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JOURNAL OF THE HISTORY OF MEDICINE AND ALLIED SCIENCES

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The Early History of the Reflex[1]

HEBBEL E. HOFF* AND PETER KELLAWAY*

INTRODUCTION

TO express the function of the whole in terms of the properties and attributes of its parts is the guiding principle of neurophysiology. This insistence upon viewing both the part and the whole and drawing the two into intimate functional relationship distinguishes neurophysiology on the one hand from biophysics, which is concerned more with the actions of single parts, and on the other from psychology and psychiatry, which are concerned more with the activities of the whole. Attempting to bridge these two extremes, the neurophysiologist encounters a deceptive simplicity in the functioning even of the most elemental unit, finding there events that can be described only in terms of dynamic interactions of form and function. In the operation of the whole he finds a complication of interacting units that even in the crudest anatomical sense is of almost infinite complexity, so extending the temporal and spatial pattern of action and interaction that the activity of the whole can no longer be predicted in terms of simple summation, but only as a complicated mathematical expression of their individual responses as determined by their relationship to one another.

The reflex is the simplest of all the actions of the whole that form the framework of behavior; it is the basic combination of units into an integrated functional pattern of response, and in fact the most primitive association of individual activities in a dynamic reaction affording a clear impression of biological purposiveness. Its whole is yet small enough and its pattern consequently the less varied and variable that explanation of its operation on the basis of the physiology of its parts has met with some success. It is, however, already complex enough to provide a clue to the understanding of function with increasing multiplicity of interneuronal associations. The reflex introduces in its most primitive form the principle of weighing and balancing a multitude of individual influences

*Houston, Texas

[1] This essay is the first of a series under the title, *An outline of the history of neurophysiology*. The authors' objective has not been to write a "history" in the usual sense of the word, but to make a developmental analysis of the subject designed to serve as a *source book*, and as a device whereby the student may achieve a more complete understanding of neurophysiology, a clearer insight into its problems, and a broader orientation in the whole field.

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at some decisive point, where the final result is expressed as an integration of the forces favoring or hindering excitation. The principle of the self-governing cycle where the effects of activity return through a nervous circuit to condition the further activity of the neuronal group is also characteristic of the reflex. But its most important feature is the escape from the rigid temporal limitations of stimulus and response inherent in the single unit. Delay in decision or a variable latent period, loss of a simple relationship between stimulus and response frequencies, and persistence of "output" activity for long periods after cessation of 'input" may be considered as prototypes in miniature of the tremendous expansion of the time scale made possible by interneuronal associations. The day is not yet at hand when the neurophysiology of behavior can be written, but the language of neurophysiology as it has developed from study of the reflex will be part at least of the vocabulary of some future account.

Whatever the future, the age that is now ending has been the age of the reflex, and whether or not the experimentation and thinking it has occasioned have or will ever have validity in accounting for the dynamics of behavior, the concept of the reflex has been for better or for worse the most significant development in neurophysiology during this period. Its growth has been more a continuum of development than a series of episodic discoveries, and in large measure progress has been made through the constant working and reworking of a few fundamental ideas and in the development of a more expressive nomenclature. Experimental and technical advances have played an important rôle—the introduction of artificial respiration, the Faradic coil, the silver stain, and the microscope, to name a few. Equally important have been the hypotheses with their various fates—the demand on purely hypothetical grounds for isolated and insulated single nerve fibers which found expression a hundred years before the axis cylinder was seen, the localization of reflex activity in the "sympathetic" ganglia, of which only a name without meaning remains, and the implications in the term "autonomic" nervous system that seemed to provide so firm a basis for visceral reflexes but nevertheless turned out to have been a false trail. Out of all this has emerged the concept of the reflex: its description and its characterization, an understanding of the mechanism by which it operates, the anatomical substratum of its being, and its functions in health and disease.

THE BACKGROUND OF THE CONCEPT OF THE REFLEX

I. INVOLUNTARY AND VITAL MOTIONS

The concept of the reflex had its beginning in the urgent demand for a nervous mechanism to account for the functions of organs which, though controlled by nerves, were not under the influence of volition. Paramount among these were the involuntary motions of skeletal muscles and the "vital" motions of the heart and intestines. The general distinction between voluntary and involuntary motions was quite as clear to the ancient writers as it is to us, and they were well aware of many unquestionably involuntary motions. Hippocrates wrote that "nature finds by itself, and not by reasoning, the means of acting; for example winking the eyes, moving the tongue, and all the other similar things. Nature, neither being taught, nor having learned, does all that is necessary" (Ref. 1, II, 233). Galen, describing the instinctive flight of an eagle, wrote in a near paraphrase of Hippocrates that it appears that animals exercise certain arts more by instinct than by reason (Ref. 2, I, 115-116).

When it came to motions which involved voluntary muscles in apparently involuntary actions, Galen was less willing than Hippocrates and many others of his predecessors to assign them to the category of the purely mechanical or "natural" functions. One example was the movements one makes while asleep. Galen recounts that he himself was once forced to walk for a whole night and was thus able to confirm that such movements are actually possible. On this occasion he walked in fact nearly the distance of a furlong,[2] asleep and lost in a dream, and awoke only on encountering a stone in his path (Ref. 2, II, 359). Perhaps because he was so preoccupied by his own discovery of the regulation of the voluntary motions through the action of the animal spirits engendered in the brain, and sought to invoke the same process for the involuntary motions of voluntary muscles, Galen was logically forced to deny that these latter motions were involuntary:

> What is then the criterion by which we can judge voluntary acts [he asked]? I can give you not only one, but many signs, all in accord with each other. In effect, if you can at your choice stop the execution of acts which have begun, and start those which have not begun, it is by the action of the will. If moreover, you are able to make them more quickly or more slowly, more frequently, or more rarely, is it not in every way evident that the act is subject to the will? The will can neither stop nor start the move-

[2] Actually, a *stadium*, or 200 yards.

ments of the artery or the heart, nor make them more frequent or more rare, nor accelerate or slow them. Thus one does not say that such acts are the acts of the soul, but of nature. Reason directs the movement of the limbs in all circumstances. In fact, it can stop a movement once begun, then renew it when it has been interrupted, and make it more rapid and more slow, more rare and more frequent. These same facts hold for the movements of respiration, which is an action of the diaphragm and the muscles of respiration, as we have demonstrated in our book On the Causes of Respiration, and which comes from the soul and not from nature, since the movement of muscles is an act of the soul. It is not right, in cases where the causes are elusive, to discard facts manifestly recognized. Thus the proofs of voluntary acts are manifestly recognized, but we are embarrassed to explain the means by which we accomplish unconsciously the movement in particular. Thus it is evident that the will governs respiration, but it is difficult to explain in what manner we fail to be aware of many voluntary acts (Ref. 2, II, 363-364).

In another book Galen did in fact describe the involuntary closure of the eyelids in excessively bright light (Ref. 2, I, 619), but this "error" was corrected in a subsequent chapter in which the violence of his language betrays, perhaps, a measure of uncertainty in his own mind:

As to the upper eye-lid, one sees it move, to be sure, but the sophists, having discovered neither the muscles that move it nor the nature of their action, have pushed their impudence to the point of declaring that this movement, far from being voluntary, is mechanical (that is to say natural or involuntary), just as the movements of the stomach, intestines, arteries, heart and other organs are independent of the will and of decision. It is better, in fact, according to them, to lie than admit their ignorance; on certain subjects the falsehood has not been detected by the public. But when the sun shines on the earth, before all eyes, only a fool could deny that there is light, or day. And if one said that we don't move our legs voluntarily in walking, but involuntarily or mechanically, this man would appear to be no less a fool than the preceeding one; for if it is possible to move them more quickly or more slowly, taking larger or smaller steps, stopping motion completely or starting off again, how foolish it is to pretend that the motion is involuntary or mechanical? If thus it were impossible, once our eyes were closed, to keep them in this state as long as we wished, then to open them at our pleasure, close them again, and to do this alternately as long as it pleases us, then the motion of the eyelids is independent of us. But if we can without hindrance accomplish these actions as we wish and as often as we wish, provided that our eyelids are in a normal state, evidently the upper eyelids are directed by our will. In fact it would be useless for us to have been given them by nature, if we could not voluntarily close our eyelids when an external object comes to strike or damage the eye (Ref. 2, I, 630).

It became even more difficult to maintain this position regarding motions that clearly overpowered volition itself, taking place despite all efforts to restrain them, such as respiration, defecation, and urination; but even when his own criteria could not be met, Galen tried to maintain their voluntary nature:

That the whole act of respiration is accomplished voluntarily by the soul is proven by the case of a foreign slave, who in a fit of anger resolved to kill himself. He threw himself to the ground and held his breath, remained for a long time immobile, and then, rolling a bit, expired in this manner. Although it is not possible to hold the breath forever, one should not for that reason deny that it is voluntary. In fact, some voluntary acts appear to us to be entirely free, while the others are subordinate to the needs of the body. The first are always executed by us without obstacle, in some degree, the latter not always, but only at certain times and in some degree. In fact, to walk toward someone, to speak, and to take something are entirely free acts; but to move the bowels and to urinate are acts which bring relief to the body. It is thus that people have kept silent for a whole year or more by the effort of their will but no one has been able to retain his excrement or his urine, I do not say for years, but even for months or a few days. Often in fact, the excrements press and torment so much, either bearing down by their weight or irritating by their acridity, that certain people have hardly the time to reach the accustomed place. The act of respiration is of the same nature, but more pressing, and of a more urgent necessity, because there is danger of death if one does not breathe and death by suffocation is extremely painful. It is thus not astonishing that it is difficult to hold the breath. In fact not many are disposed to die, even if weighed down by a thousand ills, and if one decides to die, one does not choose such a painful route. Thus even though we can at will keep silent forever while it is impossible for us to hold our breath, one should not from that conclude that the voice is a voluntary act and respiration is an involuntary and natural act. I think I have already demonstrated that (Ref. 2, II, 366-367).

Galen finally came to argue that just as we in time forget many voluntary acts, some sooner than others, so some acts can make such a small impression on the soul that they are forgotten as fast as they are executed, becoming to all intents and purposes involuntary:

Would it be astonishing, if during sleep, the soul operating in an obscure manner, perceptions were obscure and did not persist? Would it be astonishing if even when awake, when the spirit is occupied in meditation and absorbed in reflection, an excessively small part of this spirit, that which is concerned with walking, received an excessively obscure impression of the action, and in consequence forgetting it immediately, did not even remember if the act were made voluntarily (Ref. 2, II, 365)?

Here is the germ of vitalism: endowing each part of an organism with an indwelling soul which regulates the actions of that part.[3]

The Background of the Concept of the Reflex

II. The Sympathy between Parts

It was already fairly general knowledge in Hippocrates' time that the various organs and parts of the body had extensive interrelations with one another, and illness of one organ might produce

[3] It is no doubt a forecast of the psychological compartmentation of the analytic school, used in much the same way to account for somnambulism, sleep paralysis, etc.

disease in a distant part because of this fellow-feeling or sympathy between them. Hippocrates recognized especially those sympathies related to the uterus, described in the following quotation:

> It is necessary to treat uterine ulcerations with much care, because being in a soft cavity, with an exquisite nervous sensibility, and with many sympathies with the head, the heart and the mind; they grow, become malignant, and are not disposed to heal (Ref. 1, VIII, 95). [Further], if an erysipelas forms in the uterus, the feet swell, as well as the breasts and the body, the woman suffers, she has orthopnea, pains in the loins, in the hypogastrium, the sternum and the heart; trembling and heaviness in the arms and thighs; the calves tremble; sometimes also they become livid, which gives relief for a short time. The surface of the body swells, and especially the breasts, by sympathy.

To Hippocrates some at least of these cases of sympathy had a nervous origin as may be seen from his account of the sympathetic symptoms in empyema:

> One might cite many other examples in medicine where a considerable number of lesions are benign, containing in themselves the whole essence of the disease, while lesser lesions are malignant, creating endless ramifications of diseases, and having extended sympathies with the rest of the body. Fractures of the ribs represent something similar: when one or several ribs are broken, as happens ordinarily without forcing splinters into the interior and without denudation of the bone, fever rarely follows, and the number is not large of those who in this case have bloody sputum, empyema, suppurating wounds, or necrosis of the bones. But in those cases where there is contusion of the flesh against the ribs, either by a blow or in some other analogous manner, it happens often that one coughs blood; in fact the canals stretched along the concavity of each rib, and the cords[4] take origin in the most important part of the body; thus these accidents have more than once given rise to coughing, tubercles, empyemas, suppurating wounds, and necrosis of the ribs (Ref. 1, IV, 217).

Galen also recognized the sympathies; the aphorism of Hippocrates that abundant lactation in a pregnant woman indicates that the fetus is feeble he explained by the fact that the breasts and the uterus have a common venous supply (according to the Galenical view these vessels supplied the natural or nutritive spirits) and consequently the excessive supply of blood to the breasts dried up the flow to the uterus. Thus the close sympathy between these two parts results from their common blood supply (Ref. 2, II, 110-112).

The concept of sympathy was developed still further in one of his celebrated descriptions of a lesion of the spinal cord:

[4] An example of Hippocrates' failure to distinguish clearly between nerves, arteries and tendons.

For the time being, I wish to conclude this book by adding a consideration of the parts affected idiopathically and sympathetically. I recall at first, that it has already been asserted that it is more convenient to term *idiopathic* the affection called protopathic by other physicians. It is unimportant for that matter if one does call it *protopathic,* it is better not to argue about words but to understand the differences between things. When the mind is disturbed by an affection of the stomach, be it by vapors or by malignant humours that rise to the brain, one would not say that the brain is affected primarily nor that it is completely exempt from illness, but the word *sympathy* expresses very exactly what physicians themselves recognize in this state. In effect, the term *sympathy* does not indicate the complete absence of illness, but an affliction in common with another part. In all events, it would be better and more clear to say that the part sympathetically affected suffers in consequence of the affection of another part.

It is a fact that some physicians have argued confusedly as in a dream, and since they have failed from a lack of comprehension to describe clearly this fact so necessary to the development of my subject, I shall try to explain it by commencing with the following consideration: Certain functions produced by an appropriate material receive this material already prepared from other parts. It happens from time to time, naturally enough, without there existing any particular affection in the proper organs of the function, that this function is abolished by lack of the substance that produces it, as this is observed to occur with the voice; (thus we have shown that, at times, with no disease present in the organs of the voice, the voice is damaged by default of the material of which it is formed). It has been demonstrated also that *expiration* is the material of the voice, and that the intercostal muscles produce it in contracting the chest. When thus these muscles no longer act, the animal loses its voice without any disturbance in the parts pertaining to the voice itself. These parts are, to summarize them, the whole of the larynx, and to enumerate them, the three cartilages of the larynx and the muscles which move them with the nerves issuing from the brain; and finally, the glottis of the larynx, which is the principal organ of the voice. In effect, this glottis being open, and moderately contracted by the muscles, produces the sounds, but it is not possible for these to be produced unless the breath be exhaled forcibly. It is this that the intercostal muscles accomplish.

A person having fallen from a high place, striking the upper part of his back against the ground, at the end of three days had a very weak voice, and on the fourth day this person was completely mute, and moreover paralysed in the legs, without any lesion of the arms, and free of apnea and dyspnea. All parts of the spinal cord beneath the neck having been paralysed, the thorax could still be moved by the diaphragm and the six superior muscles; the nerves of these muscles arising from the cord in the neck, while all the nerves of the intercostals, which as we have demonstrated, produce expiration, were affected. The physicians wishing thus to torment the legs by a useless treatment because they were paralysed, and the larynx because of the affection of the voice, I stopped them and gave all my attention to the single part affected. The inflammation of the cord disappeared at the end of seven days and the young man recovered his voice as well as the movements of his legs.

Such a lesion should be classified as *sympathetic* with more justice than the pain produced in the head by certain humours contained in the stomach (Ref. 2, II, 494-496).

An even more appropriate example is given somewhat later in the same treatise, although a humoral mechanism is again invoked to account for it:

It is necessary to differentiate the epileptic affections with care, because these develop, partly by reason of a primary affection of the head, and partly by sympathy. In fact, nearly all physicians neglect to differentiate the epilepsies, which present three varieties, as they have neglected to distinguish the three varieties of melancholia. The epilepsies all have this in common, that the brain is affected, either by an affection arising there, as happens with most epileptics, or that it has ascended by sympathy from the orifice of the stomach ordinarily called *pylorus* by physicians. . . . There also occurs, but infrequently, another form, or species or variety, of epilepsy, whatever you wish to call it, the affection beginning in some part or another and then ascending toward the head in a manner appreciated by the patient himself. While still young, I saw this phenomenon for the first time in a young boy of thirteen years; I saw him in the presence of the most distinguished physicians of my country, meeting to consult on the treatment. I heard the child recount that the diathesis began in the leg, and thence it ascended directly to the neck by way of the thigh, the loins, and the chest, and from the neck to the head, and once the head was reached, he lost consciousness. Questioned by the physicians on the nature of this substance which ascended to the head, the child was unable to reply.[5]

The epilepsy started in the legs in the boy spoken of above. The physicians assembled in consultation attempted to cure it. They decided, after purging him completely, to apply to the part a medicament composed of thapsia[6] and mustard; they bound the limb above the point first affected, and this prevented the return of the attack, which had taken place daily.[7] This is by digression, so that one should not be astonished that such a serious malady should arise in some unimportant part.

It still remains for us to discover the cause of the epileptic convulsions that arise in such sympathies. In fact, Pelops has said nothing very reasonable in this regard, no more than any of these with whom I am acquainted. Having once seen a man attacked by a sympathy of this nature fall without violent convulsions, but agitated at intervals by light jerking movements, it seemed to me that there existed something similar to that seen frequently to occur at the orifice of the stomach in hiccups. As for me, for example, if I eat too much pear, I am immediately seized by hiccups, and I have seen the same thing happen in a goodly number of other persons with a very sensitive orifice of the stomach. I once saw, not only the hiccups, but even a convulsion of the whole body, produced by an acrid humour. This convulsion stopped immediately after the bitter humour was vomited.

It seems to me that all other symptoms affecting the nervous system arise in this fashion, and that those which cause syncope with loss of

[5] A sensory aura? The feeling of a sensation ascending from the legs and threatening unconsciousness has also been reported in cases of "jittery legs."

[6] Thapsia garganica, or deadly carrot, grows wild on the shores of the Mediterranean and from its root a powerful vesicant can be prepared. It was used by the Arabs under the name of Bou-Néfa (Father of Health) or Panacea of Esculapius.

[7] This would fit Galen's concept of an ascending humor, but hardly the modern view. The arrest of progression by sensory stimulation is well known.

consciousness but without convulsive or clonic motions, result from a sudden refrigeration.[8]

DESCARTES AND THE BEGINNINGS OF THE REFLEX

From this amorphous background the concept of the reflex began to emerge in the writings of Descartes. He started from the assumptions that nerves have both sensory and motor functions, united in a single fibre, and that all nerves terminate in the ventricles in a spatial arrangement reproducing their peripheral relationships (this is most clearly stated in his discussion of the central representation of the retina (3, vol. 11, 151). Descartes then postulated that stimulation of a sensory nerve might have one or both of two effects. It might directly open the pores of certain nerves, permitting a more ready access of animal spirits to them, and in consequence evoke an appropriate muscular action, or it might also have an effect by virtue of its influence on the soul. The first French edition of his treatise *On Man* pictures the more simple mechanism, operating without mediation of the soul (Fig. 1).

The soul itself was also able to produce voluntary motion by emitting animal spirits in this or that direction, to activate appropriate motor nerves, but there was in addition a third category of motions in which the sensory stimulation made an impression on the soul, giving rise to sensation, and at the same time initiating a flow of spirits from the soul to the nerves which moved the muscles performing the motor acts accompanying the sensation. Figure 2 reproduces the illustration of this mechanism from the first French edition.

The argument in Descartes' treatise *On Man* is lengthy and too detailed to be quoted appropriately, but fortunately a summary was given by Descartes himself in the initial chapters of *The Passions of the Soul* which, although it was published earlier, was clearly written after the more detailed treatise *On Man*. The quotation that follows is from the first English edition of 1650 (Ref. 4), which, despite its many defects as a translation, possesses the great merit of being contemporary:

The 12th Article. How outward objects act contrary to the organs of the senses. It remains yet to know the causes why the spirits slide not from the brain into the Muscles always after one manner, and wherefore they come

[8] Due to the cooling effect of vapors which reach the brain from the stomach or other parts. One should beware of implying any connection with modern concepts (cf. Ozorio de Almeida, Investigations of epileptiform attacks produced by sudden cooling of frog spinal cord. *J. Neurophysiol.*, 1943, 6, 73-79).

sometimes more toward some than others; for besides the action of the Soul, which in truth, is in us one of the causes, as I shall shew hereafter there are yet two besides, which depend not of any thing but the body, which it is necessary to take notice of; the first consists in the diversity of motions, excited in the organs of the senses by their objects, which I have already amply enough explained in the Dioptricks; but that those who see this may not need to have read aught else, I will here repeat, that there are three things to be considered in the sinews[9] to wit, their marrow or interiour substance, which stretches itself out in the form of little threads from the brain, the original thereof, to the extremities of the other members whereunto these threds are fastened; next, the skins wherein they are lapt, which being continuous with those that envelop the brain, makes up little pipes wherein these threds are enclosed; lastly, the animal spirits, which being conveyed through these very pipes from the brain to the muscles, are the cause that these thredds remain there entirely unmolested, and extended in such a manner, that the least thing that moves that part of the body, whereunto the extremity of any one is fastened doth by the same reason move the part of the brain from whence it comes; just as when a man pulls at one end of a string, he causeth the other end to stirre.[10]

The 13th Article. That this Action of objects without, may differently convey the Spirits into the Muscles. And I have made it evident in the Dioptics how all the objects of the sight are not communicated to us any way but thus; they move locally (by mediation of transparent bodies between them and us) those little threads of the Optick nerves, which are at the bottome of our eyes, and after them, the places of the brain from whence those nerves come: they move them, I say, as many severall kinds of ways, as there are diversities of objects in things; nor are they immediately the motions made in the eye, but in the brain, that represent these objects to the Soul: in imitation whereof it is easie to conceive that sounds, odours, heat, pain, hunger, thirst, and generally all objects, as well of our exteriour senses, as our interiour appetites, doe also excite some motion in our nerves, which passes by means of them into the brain; and besides, that these severall motions of the brain create in our soul different resentments, it may so be, that without her, the spirits direct their course rather toward some muscles than others, and so they may move our members; which I will prove here, only by one example. If any one lift up his hand on a sudden toward our eyes, as if he were about to strike, although we know that he is our friend, that he does this only in jest, and that he will be careful enough not to doe us any hurt, yet wee can scarce refrain from shutting them; which shews that it is not by the intermedling of our soul that they shut, since it is against our will, which is the only or at least the principale Action thereof; but by reason this machine of our body is so composed that the moving of his hand up towards our eyes, excites another motion in our brain, which conveys the animal spirits into those muscles that close the eye-lids.

The 16th Article. How all the members may be moved by the objects of the senses, and by the spirits, without the help of the Soul. Lastly, it is to be observed, that the machine of our body is so composed, that all the changes befalling the motion of the spirits may so worke as to open some

[9] Descartes himself wrote "nerfs" and it was the translator who chose the alternative meaning of "sinews," as an echo of the pre-Galenical days when "nerve" meant either a tendon or a nerve (Ref. 3, II, 337).

[10] Thus a single fibre was supposed to combine both sensory and motor functions, despite Galen's clear demonstration of the anatomical separation of sensory and motor pathways.

pores of the braine more than others: and reciprocally, that when any one of these pores are never so little more or lesse open than usuall by the Action of those nerves subservient to the senses, it changes somewhat in the motion of the spirits, and causes them to be conveyed into the muscles which serve to move the body in that manner it ordinarily is, upon the occasion of such an Action. So that, all the motions we make, our will not contributing to them (as it often happens that we sigh, walk, eat, and to be short, doe all actions common to us, and beasts) depend only on the conformity of our members, and the streame which the spirits excited by the beat of the heart, follow naturally into the brains, nerves, and muscles. Just as the motion of a watch is produced meerely by the strength of the spring and the fashion of the wheeles.

THE "SYMPATHETIC" NERVOUS SYSTEM

The necessity of prolonging each and every nerve to the brain so that it could receive its share of the animal spirits engendered there made the spinal cord a simple bundle of fibres in which each fibril took its isolated course. A development by Descartes of Galenical physiology, it hardly represented Galen's own views, which were far less precise. To be sure, Galen spoke of the spinal cord growing out of the brain like the trunk of a great tree; from this trunk, prolonged along the whole of the spine, there separate off a great number of nerves which, like branches, subdivide into thousands of twigs (Ref. 2, II, 9), but he later (pp. 31-32) compared the spinal cord to "a river which leaves its source sending to each part encountered on its way a nerve; a canal providing at the same time sensation and movement." "The spinal cord is, for the parts below the head, a second brain" (pp. 32, 41).

It was Willis, apparently, who first suggested as a tentative expression following a summary of the classical view, that all intercommunication between nerves need not take place in the brain:

Moreover, as we have affirmed, that the Instinct for the performing of Motions is brought altogether through the Nerves from the Head to the Muscles, and as every Trunk of the same Nerve, being oftentimes broken into many shoots, variously distributing them, sends it to many destinated Muscles, it may very well be doubted how the animal Spirits, conveying the Symbol of the motion to be performed with a certain choice, do actuate only these or those branches apart from other branches of the same, and do not indifferently enter all the branches or shoots of the same; to wit, as the blood passes through the Trunk of the Artery, and all its ramifications equally. The most Learned Regius,[11] that he might solve this knot, supposes

[11] The "Learned Regius" copied this, and much else, from manuscript notes which Descartes circulated among his friends and, what is more, published it before Descartes' own works were issued. Descartes wrote that what was good in Regius had been copied, while that which was original was worthless (Ref. 3, II, 672), a quotation often used since. See note 33; also Patterson, T. S., John Mayow in contemporary setting. *Isis*, 1931, *15*, 47-96; 504-546, ¶ 22.

in the Nerves some little doors, like to those which are found in musical Organs, the apertures whereof admit the Spirits to these or those parts especially, the rest being shut up. But he ought to have shewn, if not the little doors themselves, yet at least by what instinct and by whose direction sometimes these, sometimes those are locked up, and others opened. But in truth, this may rather be said, that all the shoots of the Nerves and lesser branches remain distinct and singular among themselves from the parts to which they are inserted, even to their beginnings; so that a peculiar tract of Spirits or way of passage lyes open, from the Brain and its medullary Appendix, to every Muscle and nervous part; for in truth, although the Nerves, according to their beginnings, may seem to arise from the greater Trunks; yet it will easily appear, if you shall open the trunk and those branches, that in them many little Nerves, only like hairs, for the sake of a better conduct, are collected together in the same bundle; yea, the coverings being separated, you may follow oftentimes the little Nervulets, and those single to the respective parts and members, to which they are destinated.

But in the mean time, although there be singular passages, or chanels of the animal Spirits of most Nerves, distinct among themselves; yet some do variously communicate with others through the branches and shoots sent on either side; which indeed ought to be so made, that when many Nerves together, are required to some motion of a Muscle equally, all these, by reason of the commerce mutually had between themselves, might conspire in the same action; hence, in some motions of the members, as in the striking of a Harp or Lute and other complicated actions, many Muscles cooperate with admirable celerity; so that, although many be employed at once, they perform their task severally without confusion. Besides, there is need for the Nerves to communicate mutually among themselves, because of the Sympathetical motions of the members and of some of the parts, for neither for any other cause is the Nerve of the Diaphragm inserted into the brachial branches, or those belonging to the Arms, than that the exercise of living Creatures, especially in running or flying, might be proportionate to the tenour of Respiration. Hence it also proceeds, that in any passion, the Praecordia being bound up or dilated, the countenance and aspect of the face, yea and the gestures of the hands and members are pathetically figured. We have proposed sufficient Instances of this sort in our particular History of the Nerves, so that we need not here add any thing more (Ref. 5, p. 48).

Whether or not Willis meant to include the sympathetic chain in his intercommunicating "branches and shoots" is not certain, though it seems probable that he did. It was Winslow, however, who stated the concept unequivocally. Finding structural resemblances between the ganglia of the sympathetic and the brain, he postulated that the ganglia were in fact small brains, and could therefore act as the brain did in affording a locus for the integration of the nervous actions involved in the sympathy between parts of the body, and in consequence gave to this system the name it still carries. But two brief paragraphs were devoted to the subject:

These Nerves, as I have said, are commonly called Intercostals, though this name does not agree with their Situation, or the Extent of their Course, as we shall presently see; and therefore I believe the name of Sympathetic

Fig. 1. The simplest form of the reflex. "If the fire A be close enough to the foot B, the little particles of this fire, which move as you know very rapidly, are able to move with them the region of the skin of this foot which they touch; and pulling in this way the little thread c,c, which you see attached there, they open in the same instant the entrance to the pore d,c, against which this little thread terminates: just as, in pulling one end of a cord, one sounds at the same time the bell which hangs at the other end. The entrance to the pore or little tube, d,c, being thus opened, the animal spirits in the cavity F enter therein, and are carried by it, . . . into the muscles which serve to pull the foot away from the fire . . . ."

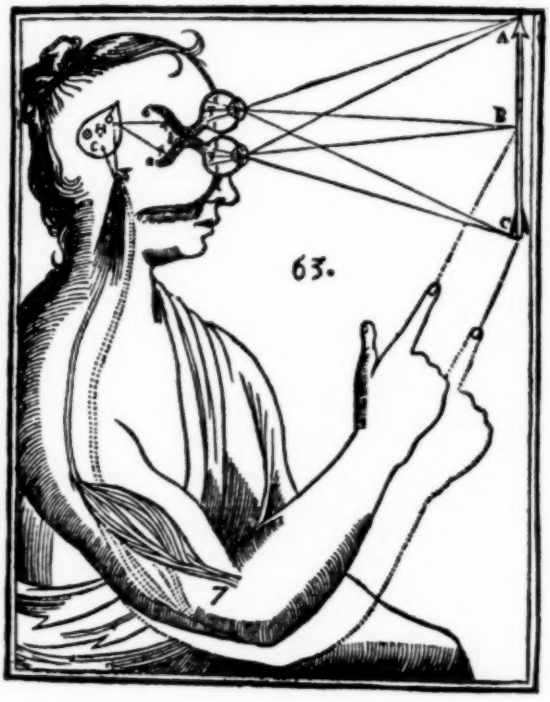

Fig. 2. The more complicated mechanism involving "reflection" of animal spirits from the "gland" which is the seat of the soul, to the nerves. The similar treatment of the rays of light reflected from the object to the retina, and of the animal spirits reflected by the gland from the endings of the optic nerve to the motor nerves is apparent.

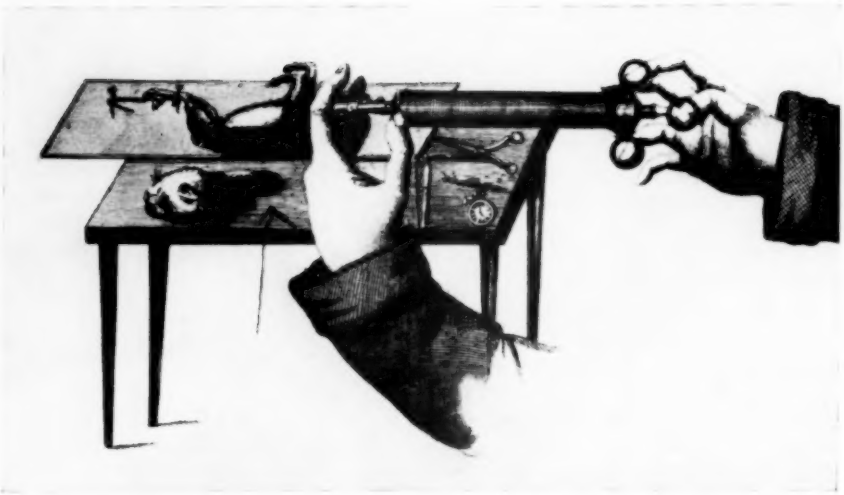

Fig. 3. LeGallois' illustration of artificial respiration in the decapitate rabbit.

Majores, or Maximi, will be more proper, because of their frequent Communications with almost all the other principal Nerves of the Body (Ref. 6, sect. 6, para. 361).

These ganglions differ more or less from each other in Size, Colour, and Consistence; and may be looked upon as so many Origins or Germinia dispursed through the great pair of Nerves, and consequently as so many little Brains (Ref. 6, sect. 6, para. 364).

THE SPINAL CORD THE CENTER FOR REFLEX ACTION: ROBERT WHYTT

The doctrine of irritability enunciated by Haller found, at least for the first half-century, more opponents than adherents; it was too complete a revolution from the Galenical doctrine of animal spirits, too great a departure from the vitalism of the time in its insistence upon a power of contraction resident in the muscle itself, and it ran counter to the vigorously growing neurogenic theory of the origin of the vital motions arising from the erroneous conclusions of Willis and Winslow. One of the most vigorous of these opponents was Robert Whytt, who in supporting both vitalism and the neurogenic doctrine, nevertheless drew an almost complete picture of the reflex.

Whytt began by a description of the pupillary reflex which still retains his name. "A more worthy cause for admiration," Galen had written, "is the opening of the pupil" (Ref. 2, I, 620), and he described how "if the animal still be alive, one sees the two membranes tensed, and, one of the eyes being closed, the pupil of the other enlarges." Giving Achillinius credit for noting the reaction of the pupil to light, Whytt argued that the phenomenon arises from sympathetic action at whatever site the nerves involved take origin:

The pupil is contracted more or less in proportion to the quantity of light admitted into the eye, not on account of any immediate action of this subtile fluid on the fibres of the *iris*, as some have imagined, but in consequence of its affecting the tender *retina* with an uneasy sensation. Hence whatever intercepts the rays of light so as to prevent their affecting the *retina*, or renders this membrane insensible to their action, causes a preternatural dilatation of the pupil. Thus when one eye is quite lost by a confirmed *amaurosis*, if the sound one is covered or kept shut, the pupil of the diseased eye remains in every degree of light immoveable, and of the same size; but if the second eye is exposed to the sun-beams, the pupil of the other, which shewed no motion before, will be evidently observed to contract. This contraction can only arise from the sympathy between the two pupils; and shews, that when the sound eye is covered, the defect of motion in the morbid one is not owing to the nerves of the *uvea* being in any way

paralytic, but merely to the want of a cause determining their influence into the orbicular muscle of the pupil.

Since the optic nerve and those of the *uvea* arise from different parts of the brain, and have no communication with each other in their course of the eye, it seems evident, that light affecting the *retina,* cannot excite the *sphincter* of the pupil into contraction, by any immediate mechanical change which it produces, either in the muscle itself, or in the nerves which activate it; but the uneasy sensation occasioned in the *retina* by the admission of too much light into the eye, may so affect the sentient principle, which is present and ready to act, where-ever the nerves have their origin, as to excite it to determine the spirits more copiously into the orbicular muscle of the *uvea,* in order to lessen the pupil, and exclude the offending cause (Ref. 7, pp. 112, 117).

Like Galen, Whytt invoked the agency of the soul in all these actions, being unable to accept the purely mechanical explanation of Descartes:

If then the effects of *stimuli* upon the muscular fibres of animals, cannot be deduced from any property or powers belonging to them as mere *material* organs, it remains, that they are owing to an active sentient *Principle* animating these fibres. But this will more evidently appear from the following consideration:

1. A *stimulus* applied to the muscles of animals when laid bare produces, instead of only one contraction lasting for a considerable time several contractions and relaxations alternately succeeding each other, which become gradually weaker, and are repeated after longer intervals, as the force of the irritating cause is diminished. Now these alternate contractions are easily accounted for, if we suppose them to proceed from a sentient *Principle,* which, in order to the getting rid of the pain or uneasy sensation that arises from the irritation of the muscle, determines the influence of the nerves into its fibres more strongly than usual.

2. If it were constantly observed, that such muscles only as had their fibres immediately acted upon by a *stimulus,* were excited into contraction, then indeed it might be suspected with greater shew of reason, that such motions were no more than a necessary consequence of the mechanical action of the stimulus upon the muscular fibres: but as we find the muscles of animals brought into action without any irritation of their fibres, whenever a *stimulus* is applied to the coats or membranes covering them, or to some neighboring or even distant part, it seems absurd to imagine such motion owing to the mechanical action of the *stimulus* upon the fibres of the muscle, and not to the impression it makes on the sentient principle. Thus the contraction of the *Sphincter pupillae* arising from the action of light on the *retina,* with which it has no communication of nerves, cannot possibly be explained mechanically, but must be owing to some sentient principle in the brain, which, excited by the uneasy sensation determines the influence of the nerves more copiously into that muscle.

3. *We* consider, that not only an irritation of the muscles of animals, or parts nearly connected with them, is followed by convulsive motions; but that the remembrance or *idea,* of things, formerly applied to different parts of the body, produces almost the same effect, as if they themselves were really present. Thus the sight, or even the recalled *idea* of grateful food, causes an uncommon flow of spittle into the mouth of a hungry person; and the seeing of a lemon cut, produces the same effect in many people.

In these cases, the motions produced in the vessels of the eyes or eye-lids, in the heart, stomach and bladder, in the secretory tubes of the salivary glands and kidneys, in the muscles employed in yawning &c. cannot be owing to the mechanical action of the causes above mentioned upon the fibres of the part moved: for what connexion is there between the optic and auditory nerves, and those which serve the heart, stomach, bladder of urine, mouth, salivary glands, and the muscles which depress the lower jaw and move the trunk of the body? All the nerves don't at last terminate in a point, but in a large space of the brain; wherefore the consent then cannot be deduced from their contiguity, but must be owing to a sentient *Principle,* which is present *at least* wherever the nerves have their origin, and which, accordingly as it is variously affected, produces motions and changes in different parts of the body.

If then the external causes affecting the brain, do, by the intervention of the mind or sentient principle, produce remarkable changes in the muscles of spontaneous as well as voluntary motion; and if the *idea* of a *stimulus* has in many cases almost the same effect as the thing itself, is it not highly reasonable to think, that stimulating things applied to the muscles of animals, excite them to contract, not by any immediate mechanical action upon their fibres, not by causing an unintelligible explosion or effervescence, or exciting strong vibrations in any ethereal or electrical matter supposed to be lodged in these fibres or their nerves; but by disagreeably affecting the sentient *Principle,* in consequence of which it determines the influence of the nerves more copiously into the fibres of the muscles stimulated (Ref. 7, p. 242 *et seq.*).

Even more clearly than Galen, Whytt saw that involuntary motions utilized the muscles of voluntary activity and elaborated Galen's explanation of "an excessively small part" of the Soul taking charge of the involuntary motions:

As I cannot therefore agree with those, who, in ascribing all our powers to mere matter, seem willing to deprive us wholly of mind; so neither, at the same time, do I see any reason for multiplying principles of this kind in man: and therefore, I am inclined to think the *anima* and *animus,* as they have been termed, or the sentient and rational soul, to be only one and the same principle acting in different capacities. Nay, *Epicurus* himself, according to *Lucretius,* did not look upon these two as separate beings, but regarded the mind as a kind of *mouvement* produced by the *anima* or Soul.

That the involuntary motions in man are not owing to a principle distinct from the rational mind, seems evident, from the muscles and organs, whose action has been generally ascribed to the *anima,* being, in many cases, subject to the power of the *animus* or rational principle; as well as, on the other hand, some of the motions of the voluntary muscles often becoming involuntary, or independent upon the will. Thus the diaphragm, whose motions in the hiccup are altogether involuntary and in ordinary respiration go on without our consciousness of them, is nevertheless subject to the immediate influence and direction of the mind; since its motions in breathing can, by an effort of the will, either be augmented or lessened, retarded or accelerated.[12] In short, there is not a voluntary muscle in the

[12] Note here the paraphrasis of Galen, and in the sentence that follows, the Galenical view that voluntary control can be exerted over some functions as long as they are not too strongly stimulated.

body whose motion does not become involuntary, as often as it is excited directly, or from its consent with some neighbouring part, affected by any considerable *stimulus*: if the irritation be very gentle, we still retain a greater or less power over the muscle; but when it becomes stronger, we lose all this power.

However, although we conceive it to be the most probable opinion that the sentient and rational principle in man are one and the same; yet we think it a very clear point, that the mind does not, as Dr. Stahl and others would persuade us, preside over, regulate, and continue the vital motions, or, upon extraordinary occasions, exert its power in redoubling them, from any rational views, or from a consciousness that the body's welfare demands her care in these particulars; for infants, idiots, and brutes of the lowest kind (which latter are destitute of reason), perform these motions in as perfect a manner as the wisest Philosopher, and the mind, when life is endangered by the too violent circulation of the blood, neither does, nor can moderate the heart's motion.

The mind, therefore, in producing the vital and other involuntary motions, does not act as a rational but a sentient principle; which, without reasoning upon the matter, is as necessarily determined by an ungrateful sensation or *stimulus* affecting the organs, to exert its power, in bringing about these motions, as is a balance, while, from mechanical laws, it preponderates to that side where the greatest weight prevails.[13]

Upon the whole, there seems to be in man one sentient and intelligent *principle*, which is equally the source of life, sense and motion, as of reason; and which, from the law of its union with the body, exerts more or less of its power and influence, as the different circumstances of the several organs actuated by it may require. That this principle operates upon the body by something in the brain or nerves, is, I think likewise probable: although, as to its particular nature, I presume not to allow myself in any uncertain conjectures; but, perhaps, by means of this connecting *medium*, the various impressions, made on the several parts of the body either by external or internal causes, are transmitted to, or perceived by the mind; in consequence of which it may determine the nervous influence variously into different organs, and so become the cause of all the vital and involuntary motions, as well as of the animal and voluntary. It seems to act necessarily, and as a sentient principle only, when its power is exerted in causing the former; but, in producing the latter, it acts freely, and both as a sentient and rational agent (Ref. 7, p. 291).

A final quotation illustrates how fully, except for verbal preoccupations with vitalism, Whytt had at this early stage already seized upon the idea of the reflex:

It remains therefore that the motions performed by us, in consequence of an irritation, are owing to the original constitution of our frame, and the law of union established by the all-wise *creator* between the soul and body,[14] whereby the former, immediately and without any exercise of reason, endeavours by all means and in the most effectual manner, to avoid and get

[13] This is a truly remarkable statement for one of Whytt's vitalistic turn of mind to make, and considered together with a quotation from Descartes to be given later (note 25) indicates that the views of neither were as rigid as has been claimed.

[14] Compare with Prochaska's "laws writ as it were, by nature on the medullary pulp of the sensorium" (note 30).

rid of every disagreeable sensation conveyed to it by whatever hurts the body (Ref. 7, p. 309).

At the very end of the book, almost as an afterthought, Whytt came to the question of the site of the sympathy between parts. An old observation, which he attributes to Redi (Robert Boyle reported a similar one, Ref. 8, II, 16), that a vertebrate can live for some time with its head cut off, made it apparent at once that the brain was not always necessary for reflex action:

Wheresoever in the present argument I have spoken of nerves being derived from the brain or *cerebellum*, I desire to be understood as including the spinal marrow, so far as it can be reckoned a continuation of the medullary substance of these parts, or to agree with them in its structure and use; for the spinal marrow does not seem altogether derived from the brain and *cerebellum*, but probably prepares a fluid itself; whence it is enabled to keep up the vital and other motions for several months, in a tortoise, after the head is cut off.

Redi informs us, that a land tortoise, whose brain he extracted by a hole made in its scull, in the middle of November, lived until the middle of May following immediately after the loss of its brain, it shut its eyes, nor ever opened them any more, but continued to move and walk about until the time of its death. When the scull was opened, its cavity appeared quite clean and smooth, and nothing was found in it except a small dry clot of blood. The same experiment he repeated on various other tortoises, some of which lived a longer, others a shorter time, but none of them less than fifty days (Ref. 7, p. 341 *et seq.*).

This new thought was developed more fully in Whytt's next book of *Physiological Essays*, published four years later. Directed mainly against Haller, it contained one new and significant fact: Stephen Hales had written to describe the effect of pithing a frog:

The very ingenious Dr. *Hales* writes me, that having many years since, tied a ligature around a frog's neck, to prevent any effusion of blood, he cut off its head, and, thirty hours after, observed the blood circulating freely in the web of the foot: the frog also at this time moved its body when stimulated; but, on thrusting a needle down through the spinal marrow, the animal was convulsed, and, immediately after, became motionless (Ref. 9, p. 176).

This classical experiment Whytt described in more detail and drew the inference that it is in the spinal cord and in it alone that the sympathy between parts takes place:

But further, it ought to be observed, that when, after decollation, a frog's spinal marrow is destroyed with a red hot wire, no visible motion is produced in its limbs, or body, by pricking, cutting or otherwise hurting them: only, when the skin of the thighs was dissected off, and the muscles were irritated, their fibres were agitated with a weak, alternate tremulous motion. Now, as the strong convulsive motions, excited by irritation in the legs and trunk of the body of a frog after decollation, are certainly to be ascribed

to the integrity of the spinal marrow, since they cease as soon as it is destroyed; Is it not highly probable, that the weak tremulous motion in the irritated muscles of a frog's thighs, after destruction of the spinal marrow, were owing to the influence of power of their nerves, which still remain entire? It seems also to deserve particular notice, that, after destruction of the spinal marrow, altho' the fibres of such muscles as were irritated, exhibited a weak tremulous motion; yet there was no sympathy between the different muscles, or other parts of the body, as was observed while the spinal marrow was entire: from whence it seems to follow, that the nerves distributed to the several parts of the body have no communication but at their termination in the spinal marrow; and that to this, perhaps alone, is owing the consent and sympathy between them (Ref. 9, p. 161 *et seq.*).

Finally, the whole subject was reviewed in a remarkable chapter on the "Structure, Use and Sympathy of the Nerves" in a more extensive text on nervous disorders (Ref. 10). It is well worth reproducing here.[15]

Before we enter upon the subject of the following observations, it may be proper to make a few remarks concerning the structure, use, and sympathy of the nerves.

1. The nerves are those small cords, which rising from the brain and spinal marrow, are distributed to every part of the body. They appear to be no more than continuations of the medullary substance of the parts whence they proceed, and owe their strength and firmness to the membranes and cellular texture which surround them.

2. The larger nerves are evidently composed of many smaller ones, which run parallel to each other, and seem to be quite distinct from their origin to their termination, without any such communications between their branches, as are observed everywhere in the system of arteries and veins.

3. The smallest nervous filaments that can be traced by dissection, are still composed of lesser threads; so that we can have no idea of the exility of a single nervous fibril.

4. Altho' it seems probable that the nerves, which are continuations of the medullary substance of the brain and spinal marrow, derive from thence a fluid; yet the extreme smallness of the nervous tubes, and the subtility of that fluid which they contain, make us altogether ignorant of its nature and properties.

5. The nerves communicate sense and a power of motion to the body.

6. Altho' every part of the body furnished with nerves, has either more or less feeling; yet there are only some of those parts whose structure renders them capable of motion, viz., the muscles, and such organs as are in part muscular; and the blood-vessels, which, from the effects of blisters and other *stimuli*, appear evidently to be possessed of irritability, or a power of alternate contraction.

7. There are only two kinds of motion observed in the bodies of living animals, viz., voluntary, and involuntary from *stimuli*. In order to the per-

[15] By deletion only of illustrations in which Whytt was in error, an entirely false picture would be presented. It is obvious that among the real examples of reflexes Whytt cites were cases of infections (tetanus), humoral transmission, and reference of pain. Taken as a whole, they afford a remarkable example of acute observation and sound reasoning.

formance of the *first*, the nervous power is not only necessary, but also a free communication, by means of the nerves, between the brain and the parts to be moved. The *second* continues for some time, though in a much weaker degree, even in those muscles whose connection with the brain is wholly cut off; whence it has been concluded, that this kind of motion is independent of the nerves, and owing to some power or property in the muscular fibres themselves, or in the glutinous matter connecting the elements of which they are composed.

8. As the nerves are continuations of the medullary substance of the brain and spinal marrow, it is probable that they are partly nourished by those vessels, which are spread on that production of the *pia mater* which surrounds them, in the like manner as the brain derives its nourishment from the arteries of the *pia mater*.

9. Our bodies are, by means of the nerves, not only endowed by feeling, and a power of motion, but with a remarkable sympathy, which is either general and extended through the whole system, or confined in a greater measure to certain parts.

10. That every sensible part of the body has a sympathy with the whole, will sufficiently appear from the following facts.

Cold water thrown on any part of the body that is warm, produces a sudden contraction of the whole vessels and pores of the skin, and by that means frequently puts a stop to small haemorrhage.

When the brain is wounded, inflamed, suppurated, or otherwise hurt, almost every part of the body is liable to suffer, and vomitings, tremors, convulsions, palsies &c. often ensue. In animals newly dead, the whole muscles of the trunk and extremities are strongly convulsed, when a probe is pushed down through the spinal marrow.

Many more examples might be mentioned, where necessary, of that general sympathy which prevails throughout the whole body.

11. Besides this general consent which prevails throughout the whole body, there is a peculiar and very remarkable sympathy between several of its organs, by means of which, many operations are carried on in a sound state; and pain, convulsive motions, and other morbid symptoms are often produced in such parts as have no near connection with those that are immediately affected.

To illustrate this, I shall give several instances, beginning with the head, and taking in the parts of their order downwards.

(*a*) *The Head.* Violent pains in the head, which have their seat most commonly in the membranes of the brain or *pericranium*, are frequently attended with a sickness at the stomach, and vomiting. The *spasmus cynicus*, locking of the jaws, and a universal *tetanus*, have followed a wound of the left side of the head, by which the temporal muscle was divided.

Grief, vexation, or fear, lessen the secretion of the *saliva*, destroy the appetite, and sometimes occasion a looseness. The great consent between the brain and heart, appears from the remarkable effects of the passions on the latter.

(*b*) *The Eyes.* Where one eye is affected with an inflammation, a cataract, or the *gutta serena*, the other is often soon after attacked with the same disease.[16] The contraction of the pupil is not owing to the light acting as a *stimulus* on the *iris*, but solely to the sympathy between this membrane

[16] We still speak of "sympathetic" ophthalmia.

and the *retina*. There is such a sympathy between the two pupils, that, even in a *gutta serena*, the pupil of the morbid eye is observed to follow the motions of the sound one. We shut both eyelids, whether we will or not, as often as anything threatens to hurt either eye. A bright light coming suddenly on the eyes sometimes occasions sneezing. Hippocrates has observed, that the unexpected sight of a serpent will make the countenance pale. The sight of grateful food occasions an uncommon flux of the *saliva*, in a hungry person. Yawning and vomiting are often catching.

(*c*) *The Ears.* The noise of a file and other harsh sounds affect the teeth with an uneasy sensation. The whetting of a knife has caused the gums to bleed. Great and unexpected sounds, such as the explosion of a cannon or musket, make us instantly close our eye-lids.

(*d*) *The Nose.* The *effluvia* of hungry water, or spirits of wine drawn strongly into the nostrils, increase the derivation of the salival juice into the mouth, and sometimes stop a tickling cough. The smell of grateful food makes the *saliva* flow when one is hungry. Sternutatories not only increase the secretion of the nose, but also from the lachrymeal vessels. After smelling too volatile salts, or eating too much strong mustard with one's meat, a pain is often felt above the eye-brows; and it is observable, that after taking a large draught of very cold water in winter, that part of the forehead immediately above the nose is affected with a painful sensation.[17]

(*e*) *The Teeth.* A rotten tooth will sometimes occasion a violent pain in a sound one, though at a distance from it; and the pain will cease as soon as the spoilt one is drawn, or its nerve destroyed. A pain in the teeth often affects the cheek-bone, one side of the head, the throat, and the corresponding ear.

(*f*) *The Trachea.* An irritation of the windpipe, or any of its small branches, raises coughing, or a convulsive motion of the muscles employed in expiration; and a *nausea*, vomiting, and convulsions, are sometimes the consequence of a violent or long continued irritation of these parts.

(*g*) *The Lungs.* The sympathy of the lungs with the diaphragm and intercostal muscles is evident from their motion, even in ordinary respiration, but still more so in the laborious breathing which is always the consequence of a difficult passage of the blood through the pulmonary vessels.[18]

(*h*) *The Diaphragm.* When the diaphragm is inflamed, the stomach, brain, and muscles of the face are affected by sympathy, as appears from the delirium, vomiting, and *risus sardonicus*, which attends this disease.

(*i*) *The Stomach and Intestines.* A disordered state of stomach and intestines, with wind or noxious humours lodged in them, will sometimes so affect the brain as to deprive people of their reason. The headache, after a debauch, proceeds chiefly from the stomach, as appears by the removal of the pain upon drinking a few glasses of strong wine. Long continued vomiting and purging occasions violent cramps of the muscles of the legs and thighs; and the dry belly-ache brings on a palsy of the extremities. A violent spasmodic pain in the stomach or intestines often renders the pulse much slower than in a state of health.

(*k*) *The Liver.* Stones irritating the biliary ducts frequently occasion a *nausea* and vomiting. An inflammation of the liver is generally accompanied

[17] This has been described recently as "ice-cream headache."

[18] Another statement that seems more significant in the light of subsequent events than it probably was at the time it was written.

with a vomiting and the hiccups, and often with a pain between the *vertebrae* of the neck and top of the shoulder.

(*l*) *The Kidneys and Ureters.* A *nausea,* vomiting, costiveness, and inflammation of the bowels, are often produced by an inflammation in the kidneys, or stones in the *ureters.* A stone in the pelvis of the kidney, or in the *ureter,* sometimes occasions a frequent inclination to make urine, and a heat in the extremity of the *urethra.* When one of the kidneys is inflamed, little urine is separated by the other, probably on account of a spasmodic stricture of its secretory vessels.[19] When a stone is passing through the *ureter,* the testicle of the same side is frequently drawn upward, and swells; and an erect posture is then painful.

(*m*) *The Bladder and Rectum.* An irritation of the neck of the bladder, or extremity of the *rectum,* is the cause of a constant contraction of the diaphragm and abdominal muscles. A *strangury* and *tenesmus* mutually occasion each other. A stone or ulcer in the bladder is attached with a sharp pain near the end of the *urethra,* especially after making water. I had some years since a patient with an ulcer in the bladder, who when he passed his urine, had not only a violent pain in the point of his *penis,* but this pain descended down his thighs and legs, and affected the soles of his feet, as if he had been standing bare-footed on burning coals.

(*n*) *The Genitals in Man.* At the time of puberty, not only the voice, but the whole body, undergoes a sensible change, which is probably owing to the *stimulus* communicated to the nerves of the genital tract by *semen;* for we certainly know that other *stimuli* applied to the nerves of the nose or stomach, according to their nature, will either instantly import new vigour to the whole body, or soon occasion a general *stupor* and debility. It is owing to a sympathy with the *glans,* that the vesiculae seminales are contracted in time of coition; and, when the membrane which lines the lower part of the *urethra* is stimulated by the *semen,* the *acceleratores urinae* are excited into convulsive motions.

(*o*) *The Uterus.* The great variety of symptoms in the hysteric disease, is the reason why a more extensive sympathy has been ascribed to the womb than to any other part, except the brain. But there is no part so much affected by the different states of the womb as the breasts, which become more turgid every appearance of the *menses,* and subside after the period is over. The changes that happen to the breasts in time of pregnancy, and after delivery, are still more remarkable.

(*p*) *The Extremities.* Short shoes give some people a headache, while sinapisms applied to the soles of the feet, or blisters to the legs, often lessen, and sometimes remove, a *delirium.* By tickling the soles of the feet, not only the muscles of the legs, but of the whole body, may be thrown into convulsions. An *opisthotonus,* with convulsions returning every day, has been owing to the wound in the sole of the foot by a nail[20]; and the *spasmus cynicus* to a violent pain in the toes. The lockings of the jaws sometimes happen after amputations of the extremities, or lacerations of the nerves or membranes.

12. All sympathy or consent supposes feeling, and therefore must be owing to the nerves, which are the sole instruments of sensation. When the hinder toes of a frog are wounded, immediately after cutting off its head, there is either no motion at all excited in the muscles of the legs, or a very inconsiderable one. But, if the toes of this animal be pinched, or wounded with

19 "Sympathetic" anuria.

20 The classical case history of tetanus.

a pen-knife, ten or fifteen minutes after decollation the muscles, not only of the legs and thighs, but also of the trunk of the body, are, for the most part, strongly convulsed, and the frog sometimes moves from one place to another. In this case, is not the irritation of the toes, immediately after decollation rendered ineffectual to produce any motion in the muscles of the legs and thighs, by the greater pain occasioned by cutting off the head?[21]

But further, that all sympathy is owing to feeling, and consequently proceeds from the nerves, appears evident, because the changes in the body, occasioned by the sympathy of the parts, are stopt by whatever affects the nervous system so strongly as to overcome the sensations that produce these changes. Thus the hiccup is stopt by terror, fear, surprise, or other strong emotions.

13. Those sympathies which have been ascribed by some authors to the *tela cellulosa*, blood vessels, membranes, and the similarity of parts, if duly considered, will appear either to proceed from the nerves, or not to deserve the name of consent or sympathy.

14. Although it may appear, from what has been said, that all real consent between the different parts of the body is due to nerves; yet it will be found very hard to account particularly for the various instances of sympathy, either in a sound or morbid state.

The prevailing opinion has been, that these sympathies are owing to the communications between the nerves, and particularly to the connection which the intercostals have with fifth, sixth, and eighth pairs, and with almost all those which proceed from the spinal marrow. Upon this principle, it has been thought easy to trace the various sympathies, not only between the several parts of the *abdomen*, but also between them and the head, neck, *thorax*, and extremities. But, however plausible this theory may appear at first view, and however readily so ever, it may seem to explain many remarkable instances of consent, yet a more strict examination will shew it to be liable to insuperable difficulties.

(*a*) Since every individual nerve appears to be quite distinct from every other, not only in its rise from the medullary substance of the brain or spinal marrow, but also in its progress to that part where it terminates, it follows that the various parts of the body cannot be due to any communication or *anastomosis* of their nerves, and consequently, that it can be here of no use, minutely to enquire into the numerous connections which the intercostal nerves have with the fifth, sixth, and eighth pairs, and with those of the spinal marrow.

(*b*) If there were any *anastomosis* or real communication between the nerves of the same or different trunks, either in the *ganglia*, or elsewhere, it is natural to think, that confusion would necessarily happen in our sensations, as well as in the motions of our several muscles; for the impressions of external objects would be communicated, at the places of union, to other nerves than those affected; and the change produced by the will in any nerve, at its origin in the brain or spinal marrow, in order for moving a particular muscle, would affect all those nerves with which it has any communication by means of the ganglia or otherwise.

(*c*) It does not appear, that there is any sympathy between the nerves that are derived from the same trunk, by means of the membranes that surround them. If the *dura mater* were endowed with that degree of sensibility,

[21] Here Whytt is first to propose the "irritation" theory of spinal shock, which he had first described in *Physiological essays*.

and with those powers of oscillation, which have been ascribed to it by several authors, this opinion would not appear altogether improbable; but as the membranes of the brain and those productions of them which surround the nerves, seem, in a natural state, to be possessed only of a very obtuse kind of feeling, and are altogether destitute of motion, we have no reason to ascribe the various instances of sympathy between the various parts of the body to their sensibility or moving power.

(*d*) We observe a remarkable sympathy between many parts whose nerves have certainly not the smallest communication with one another. Thus the dimness of sight occasioned by a disorder of the stomach, the *nausea* upon seeing others vomit, and the flux of the *saliva* into the mouth of a hungry person, at the sight of savory foods, are proofs that the stomach and salivary glands sympathise with the *retina*, though there is no communication between the optic nerves and any other. Although the nerves of the two kidneys do not appear to have any connections with each other; yet, when one of these glands is inflamed or irritated by a stone, the secretion from the other is frequently much diminished. The nerves with which the uvea of the two eyes are furnished have no connection and yet we find a most remarkable sympathy between the motions of the two pupils.

(*e*) If the consent between the *viscera* of the *abdomen*, and the other parts of the body, be owing to a communication of nerves, by means of the intercostals; why do not all those parts sympathize whose nerves are either derived from, or communicate with the intercostals? Why, in the *nephritis*, does the stomach suffer more than the intestines: and why are not the lungs and other parts at all affected in this disease? Why does not an irritation of the bladder from a stone commonly occasion a *nausea* and vomiting: since the bladder, as well as the kidneys, has its nerves partly from the eighth pair and intercostals?

If the sympathy between the nose and the diaphragm be owing, not to the olfactory nerves, but to a branch of the fifth pair sent to the nose, why do not sternutatories excite convulsive motions of the muscles of the face, to which the fifth pair is distributed, as well as spasms of the diaphragm, whose nerves can have only a remote connection with the fifth pair, by means of the intercostals? These questions, I doubt, will scarce admit of a satisfactory answer, upon the principle of sympathy depending on the communication or connection of nerves.

15. If, therefore, the various instances of sympathy cannot be accounted for from any union or *anastomosis* of the nerves, in their way from the brain to the several organs; and if there are many remarkable instances of consent between parts whose nerves have no connection at all; it follows, that all sympathy must be referred to the brain itself and the spinal marrow, the source of all the nerves.

But, for a more direct proof of this, we may observe, that the consent of the several parts instantly ceases, when their communication with the origin of the nerves is interrupted. Thus, though the muscular coat of the stomach, in an animal newly dead, is excited into contractions by irritation; yet the diaphragm is noways affected by this *stimulus*. In like manner, when any of the muscles of the legs of a frog are pricked, most of the muscles of the legs and thighs contract, even after cutting off its head, if the spinal marrow be left entire; but when that is destroyed, although the fibres of the stimulated muscle are affected with a weak tremulous motion, yet the neighboring muscles remain wholly at rest.

Lastly, notwithstanding the many sympathetic motions which are daily observed, by physicians, to arise from an irritation of the nerves in different parts of the body; yet, when the nerve going to any muscle is irritated, there is no motion excited in any part, except in the muscle to which it is distributed. Does it not hence appear highly probable, that the various sympathetic motions of animals produced by irritation, whether in a sound or morbid state, are owing, not to any union or connection of their nerves, but to particular sensations excited in certain organs, and thence communicated to the brain or spinal marrow?

But although, from what has been said, it may appear probable, that all nervous consent proceeds from the brain; yet we cannot pretend, from this principle, to account, in a satisfactory manner, for all the various instances of sympathy observable in the bodies of animals; since many of them depend on such a state of the brain, and other parts, as cannot be the object of our senses.

If it should be objected, that it is as difficult to account for a sympathy between the nerves at their origin in the brain, as in their course to the several parts where they happen to be connected; I answer, that the purpose of these observations is not to explain how the different parts of the body can be endowed, by means of the nerves, either with a sentient or a sympathetic power, but to endeavour to trace the sympathy of nerves to its true source, which I take to be the brain and spinal marrow. It would be vain to inquire into this matter, unless we knew the minute structure and connections of the several parts of the brain, and were better acquainted with the union of body and soul, to whose sentient power the sympathy of the nerves, at their origin, must be at last referred: For, if consent supposes feeling, and if feeling cannot, any more than intelligence, be a property of matter, however modified; it must follow, that sympathy depends upon a principle that is not mechanical; and that, to suppose it may be owing to the particular situation, arrangement, or connection of the medullary fibres of the brain, or to the union of nerves proceeding from it, is as unreasonable, as to imagine that thought may be the result of a motion of the particles of the animal spirits, or other subtile matter in the brain.

19. There are many of the most remarkable sympathetic motions, both in a sound and diseased state, in which we can plainly perceive a wise intention. Thus the contraction of the pupil when light offends the eyes, and of the eye-lids when grosser bodies threaten to hurt them; the vomiting from a stone in the kidneys and ureters; the coughing occasioned by an irritation of the *meatus auditorius;* the continued contraction of the abdominal muscles and diaphragm in a *tenesmus,* a strangury, and during the pains of labour; the alternate contractions of the same muscles in sneezing, coughing and the hiccup; the increased motion of the organs of respiration in a fit of an asthma; the copious secretion of tears and the *saliva,* when stimulating substances are applied to the eyes, or taken into the mouth; and the uncommon flux of humours to every part that is irritated. All these, and many more, are the efforts of nature to free the body of something hurtful; and are so many instances of that principle of self-preservation so conspicuous in all animals.[22] These motions, therefore, cannot in my opinion, be referred to any connection or communication among the nerves, but to the brain itself, and to that *sentient* being which activates our whole frame,

[22] A first statement of the "purposiveness" of reflexes, recognizing only the protective aspect.

and which endeavours at all times, to free the body from whatever occasions pain or uneasiness.

Indeed, when these efforts to expel the offending cause, as in great inflammations of the stomach, or when a large stone is lodged in the kidneys or bladder, they often become hurtful, and increase the pain they were intended to remove. Nay, as in many other instances the best may, by excess, become the worst; so this endeavour to free the body, or any of its parts, from what is noxious, is sometimes so strong and impetuous as to have fatal consequences. But, in general, this principle of preservation is highly useful, since without it we should often cherish, within our bodies, such causes as would sooner or later end in our ruin.[23]

It was nearly half a century before the crucial experiments of Whytt were extended to mammals by Fontana and LeGallois. Fontana had been occupied with studies on the site of action of the venom of the viper and other poisons and had wished to observe their action on mammals deprived of the brain; noting that breathing stopped when an animal was decapitated, he quite naturally started artificial respiration by manipulation. He made no mention of the neurophysiological implications of this experiment (Ref. 11).

LeGallois' (Ref. 12) approach was designed to discover the nervous centre regulating the action of the heart and circulatory system, and he soon perceived that when a mammal was decapitated, it died, not of primary circulatory failure, but of asphyxia; and he, too, naturally turned to artificial respiration (learning of Fontana's priority only after he had reported his own experiments):

From the connection of these facts, I conclude that the decapitated animal is only in a state of asphyxia, and that he is so because he can no longer perform the motions necessary to introduce air into the lungs. Substituting the artificial inflation of the lungs instead of natural respiration, affords a ready means of ascertaining the correctness of this conclusion. Accordingly I made the experiment, and the success was complete. To succeed it is not even necessary that the lungs should be inflated immediately after decapitation. This was not performed until sensation and voluntary motion had ceased; these will soon be restored, and be strongly characterized; and if the inflation be interrupted, they are again enfeebled, at last disappear entirely, and the animal appears dead; but they reappear with the same intensity if the inflation is renewed. I repeated this experiment with the same success on dogs, cats, and guinea-pigs. In a word, a decapitated animal may in this manner be kept perfectly alive, during a time varying according to the age and species, and which in young rabbits is at least several hours (Ref. 12, p. 46) (Fig. 3).

No more than Whytt and Galen was LeGallois able to escape from vitalism, or rather, its terminology, and he was forced to

[23] A forecast of the reflex in pathology, as the foundation of diseases of accommodation or over-compensation.

conclude that the spinal cord was the seat of sensation and the source of voluntary motion:

> It is evident from these facts that the principle of sensation and voluntary motion does not reside in the brain, according to the usually received opinion, or at least, that the brain is not its exclusive seat. But where then is the seat of this principle? Is it peculiar and circumscribed, or is it disseminated over every part of the body? The following experiments soon convinced me that it resides only in the spinal marrow. Thus if in a decapitated rabbit, which has been most completely revived, and which is kept alive by the inflation of the lungs, the medulla spinalis be destroyed, by pushing an iron rod through the whole length of the vertebral canal, all the phenomena of life instantly disappear, nor is it possible to restore them by any means; only those of irritability are left, which it is known always continue some time after death.

REFLEX: ORIGIN AND DEVELOPMENT OF THE TERM

It is apparent from the foregoing that although the observations of Whytt provided the data essential for an understanding of reflex activity, the vocabulary of vitalism and of voluntary and conscious activities proved inadequate to describe the new facts and their significance, and only by development of new terminology, and in particular the adaptation of the term *reflex,* was the concept fully established.

The word "reflex" is of great antiquity in its purely physical sense of turning back rays of light, etc., and it rapidly developed a psychological meaning implying by "reflection" the turning back of the mind to past events, or the mental reviewing of a subject. Whytt and Descartes employed the word in this sense on many occasions. But it is almost certainly from its purely optical connotation that the word as applied in neurophysiology is derived. Descartes had a particular interest in optics, and many of his physiological illustrations were drawn from the eye and its connections with the brain. In his treatise *On Man* Descartes described minutely the reflection of light into the retina from an object appearing in front of the eyes and indicated how the retinal images created a nervous disturbance at the terminations of the fibres of the optic nerves in the ventricles of the brain, having the same spatial relationships as the image in the retina.[24] These images then converged on the pineal gland, creating there a single image. Thence the animal spirits moved, depending upon the part of the gland involved and its orientation to the orifices of the nerves surrounding it, to initiate motor acts appropriate to the impres-

[24] The phenomenon of point-to-point representation still finds its best illustration in the central projections of the retina.

sion made on the soul. Figure 2 shows how the lines of optical reflection are continued within the cavities of the brain to indicate the flow of animal spirits from the terminations of the optic nerves to the gland and from there to other nerve endings. (The figure is unfortunately not Descartes' own, but follows closely his detailed description, being prepared for the first French edition of 1664.)

It is only natural that in describing this process, the word "reflect" should be carried over from the optical part of the description to the neurophysiological aspects, and this is apparently what did happen, not in the original treatise *On Man,* but in the epitome on *The Passions of the Soul,* as follows:

The 35th Article. An example of the manner how the impressions of objects unite in the kernell in the middle of the brain. As for example; if we see any creature come toward us, the light reflected from his body, paints two images, one in each eye, and these two images beget two others, by intercourse with the optic nerves, in the interior superficies of the brain, that look toward its concavities: from thence by intercourse of the spirits wherewith these cavities are filled, these images glance in such a manner on the little kernell, that these spirits encompass it, and the motion which composes any point of one of these images tends to the same part of the kernell, to which the motion tends that frames the point of the other image, which represents, too, part of this creature: by which means the two images in the brain make up but one single one upon the kernell, which acting immediately against the Soul, shews her the figure of that creature.

The 36th Article. An example of how the passions are excited in the soul. Furthermore if this figure be very strange and hidious, that is, if it have much similitude with such things as have formerly been offensive to the body, it excites in the Soul the Passion of fear, afterwards, that of boldness, or else an affright or scaring according to the various temper of the body or the force of the soul, and according as a man hath formerly protected himself by defense or flight against noxious things whereunto the present impression hath some resemblance; for this renders the braine so disposed in some men, that the spirits reflected[25] from the image so formed on the kernell, go from thence to fall, part into the nerves, which serve to turn the back, and stirre the legs to run away, and part into those which (as is spoken of before) let out or draw together the orifices of the heart, or which else so agitate the rest of the parts from whence the blood is sent, that this blood not being so rarified there in the usual manner, sends spirits to the braine that are fitting to maintain, and confirm the passion of fear, that is, such as are proper to hold open, or open again the pores of the brain that convey them into the very same nerves, for the meere entry of these spirits into these pores excites in this kernell a particular motion, instituted by nature to make the soul feel that passion; and because these pores relate

[25] It should be noticed that in the only place Descartes uses the word "reflect" it is not to describe the simple mechanical response of the motor nerve to an afferent stimulus (Fig. 1) but a more complex response involving the soul and varying according to the disposition of the soul and the individual's constitution and past experience. The reflex was therefore not even to Descartes a rigid and invariable response. Compare with Whytt's statement (note 13).

principally to the little nerves that serve to lock up or open wide the orifices of the heart, this makes the Soul feel it, as if it were chiefly in the heart (Ref. 4).

Willis used the word "reflex" in a paragraph that almost certainly is derived from Descartes.

Imagination follows the Sense: Then if the same fluctuation of Spirits is struck against the Cortex of the Brain, as its utmost banks, it impresses on it the image or character of the sensible Object, which, when it is afterwards reflected or bent back, raises up the Memory of the same thing.

The active Powers of this Soul, viz. Local Motion, Memory, Phantasie, and Appetite follow sometimes immediately the Passions, sometimes are induced apart from them upon other occasions. For indeed the sensible impression striking the streaked or chamfered bodies, oftentimes, the Brain being in no wise affected, causes the Local Motions to be retorted with a reciprocal tendency of the animal Spirits; so in sleep (the Appetite knowing nothing of it) when pain troubles, presently we rub the place, moving the hand to it: but more often, after that the sensible Species, having past from the common Sensory to the callous Body, hath stirred up the Imagination, the Spirits, reflecting from thence, and flowing back towards the nervous Appendix, raise up the Appetite and Local Motions, the Executors or Performers of the same; And sometimes a certain sensible impression, being carried beyond the callous body, and striking against the Cortex of the Brain, itself, raises up other species lying hid there, and so induces Memory with Phantasie, also often with Appetite and Local Motion associates. Further, these active Powers, sometimes upon other occasions, are wont to be stirred up and exercised apart from Passion. In man, the Rational Soul variously moves the sensitive, and at its pleasure draws forth and brings into act its Powers, sometimes these, sometimes those. Moreover, the blood boiling up above measure, and by this means striking impetuously the border of the Brain, excites the species of things lurking in it, and driving them forward towards the middle or marrowy part of the Brain, causes also the various Acts of Phantasie and Memory to be represented (Ref. 5, p. 96).

It should be noticed that both Willis and Descartes employed the term *reflect* to describe a phenomenon involving the soul where the stimulus "stirred up the Imagination" before motion was produced. Therefore, neither Descartes nor Willis employed the term to designate those purely unconscious and involuntary motions which we would now recognize as "reflexes," although this appears to be solely an accident of terminology, at least in the case of Willis who used the expression "retorted" for such motions.

Whytt, although well acquainted with the work of both Willis and Descartes, did not use the term "reflex" in this sense. It is obvious that the thought of a simple mechanical reflexion of animal spirits, even when the seat of the Soul was itself involved, was repugnant to Whytt, even though he had been forced to the conclusion that in performing such acts the soul was constrained to act by virtue of the original constitution of our frame just as a

balance is thrown from one side to another by the weights placed upon it.

However, soon after the publication of the last of Whytt's works there appeared a *Treatise on the Principles of Physiology* by John Augustus Unzer in which the concept of reflex action was more clearly enunciated. Unzer, in the words of his translator, "lived and wrote far in anticipation of his age and his contemporaries. That which he established hypothetically, but logically, has since been demonstrated by dissection and experiment; what he thought to be only perceptible to the eye of reason, has been revealed to the eye of the histologist; what he discovered, intuitively but speculatively, has been duly enrolled on the records of science as a proven thing" (Ref. 13, p. viii).

This analysis is without question overly enthusiastic, for Unzer's work was in many respects almost pure Cartesian physiology modified by the Hallerian doctrine of irritability, and its chief contribution was the revival and establishment of the term "reflex." The cortex of the brain was to Unzer what it was to Descartes, "almost wholly a tissue of tubes; not the organ of the conceptive faculty, nor the seat of the animal sentient forces, but the organ for secreting the vital spirits, which it supplies to the medulla of the brain, and thence to the entire system of animal machines; in this respect it can be considered as a viscus of the head, whose proper function is the secretion of certain fluids from the blood" (Ref. 13, p. 83). All nerves arise in the brain (p. 87). In an intact animal external stimuli are reflected in the brain just as Descartes postulated, but Unzer made free use of the word "reflex" to describe the process:

> If a nerve causes nerve-actions, by means of an external impression in parts remote from the point of impression, or even at the point itself, but through other fibrils than those which primarily receive the impression, or through its own efferent fibrils, the impression is transmitted along the nerve upwards to the brain; but ere it reaches there, it is turned from its course, and so reflected downward, that it excites (as an internal impression) the nerve of other remote parts, or the nerve-twigs or efferent nerve fibrils of the part receiving the impression; and this internal impression, which is nothing else than the reflected external impressions, thus reaches the mechanical machine which has to perform the nerve-action. This is proved by undoubted experiments. If the toe of a frog at rest be pricked, the external impression thus made goes to the brain. From thence it is reflected upon the limbs, and the animal rises up and springs forward (Ref. 13, pp. 223-224).

Unzer was aware, however, of the motions of the decapitated frog, for he continued:

> But if the head be cut off, and the toe be again pricked, the same motions take place. In this case the external impression on the toe must pass upward toward the brain, although it cannot reach it, for if the nerve be divided in the thigh, so as to prevent its transmission, the motion does not take place. Further it is obvious that it is reflected on the nerves of the limbs, as an internal impression, and along their twigs to their muscles, because no other part of the body, except this single toe which was pricked, receives an external impression. . . . The reflected external impression passes as an internal impression to, and only excites motion in those muscles to which it can be transmitted from the point of reflexion (Ref. 13, p. 224).

Just where Unzer believed the point of reflection to be located is not entirely certain. He seems to have included the spinal cord as at least one such reflex centre, to judge from his statement: "It is the same with the nerves which arise from the spinal cord, and which probably have the twofold functions of transmitting to the spinal cord the impressions they receive, that they may be sent directly forwards to the brain and subserve to sensation; or that they may be reflected in the spinal cord on other nerves, and thus induce certain movements which otherwise would not have resulted from those impressions" (Ref. 13, p. 34). The effect of this is somewhat weakened by a further statement, that "when a decapitated frog leaps from pinching its toe, the action is a nerve-action of an internal impression derived from a reflected external impression. The external impression in this case can pass uninterruptedly from the point of irritation in the toe to the point of injury in the spinal cord, where it is reflected,[26] and passes uninterruptedly back again, and thus the same nerve action is caused by it, as if a primary internal impression had excited the spinal cord" (Ref. 13, p. 260).

Unzer likewise accepted the view that the ganglia and plexuses might also serve as reflex centres: "The external impression must be transmitted upwards, to that point of the nerve where it is reflected, and changed into a non-conceptual, internal impression; as, for example, to that point when the efferent fibrils of the nerve are excited by the external impression, or where the nerve-fibrils are given off which subserve to the required nerve-action; or to the ganglia; or to the plexuses which contain them" (Ref. 13, p. 227).

Further, Unzer was inclined to believe that reflexion occurred even in muscles themselves.

> When many muscular bundles are united together, so as to form bundles, the motion excited in one readily extends to others, and puts the whole

[26] This would appear to postulate some sort of ephaptic transmission at the cut surface.

bundle into action; or, if a viscus be made up wholly of such bundles, the whole machine may thus be excited to action, as is the case with the heart, stomach, intestines, etc. This compound and communicated action is as much a direct nerve-action, as if only one fibril had been excited to contract; consequently, when the motions of the heart, or of portions of the intestine, are renewed after their removal from the body, by pricking with a needle, direct nerve-actions are produced.

Nevertheless, it is not advisable thus to consider them. For firstly, the movements excited in the fibrils connected with those primarily irritated, is only a mechanical result. Secondly, it may be considered as a nerve-action, the direct result of an internal, or the indirect nerve-action of an external impression, and this may take place as follows. The nerve entering a muscle is distributed to every fibril of it, otherwise every portion would not be sensitive. Consequently, there must be numerous points of division of the nerve in the substance of the muscle, at which an external impression on its way upwards can be reflected, and changed into a non-conceptional impression. This reflexion of the impression can excite indirect nerve-actions in all other parts of the muscle[27] (Ref. 13, pp. 239-240).

This reasoning was applied more particularly to the heart, following a suggestion by Haller: "Since the heart is compounded of several muscles, and since these can be excited to action independently of each other, as has been shown in excised hearts, it is more probable, that the stroke of the heart, or the combined action of all the muscular structures, is an indirect-nerve action of external impressions, they being reflected in the heart itself. . . ." (Ref. 13, p. 268).

Unzer also considered the important question raised by the discovery of the reflex action of the cord. If in the intact animal an external impression were conducted to the brain, and there evoked both a sensation and a reflected motor action, what real function had spinal cord reflexes in the intact animal?

When the toe of a decapitated frog is pinched, it places its limbs in a position for leaping, and actually leaps, in consequence of the indirect nerve-action caused by the external impression on the toe; and the question arises whether the same impression, when felt, would cause the same leap as a sentient action of the pain caused, either indirectly or incidentally, in consequence of the excitement of an instinct? Probably it is so, for a healthy frog leaps when it feels the pain caused by pinching the toe; but in this case is the leap necessarily a sentient action caused by the pain? for although it may take place as such at the same time that it occurs as a nerve action, still it does not follow, that in the case of the healthy frog, the leap is so produced. How can it be shown, experimentally, whether it occurs from the sensation of the external impression, or from the impression only? Everything which prevents the action of the external impression, also partly prevents its being felt, and if felt, partly prevents the same movement being excited as a sentient action of the sensation. Other difficulties might be

[27] The axon-reflex appears to be the closest modern counterpart of this mechanism.

mentioned, and in fact, there is only one means of solving the problem.

A person dreams that his finger is touching a hot stove and withdraws his whole arm, as if he really touched it. This retraction is the imperfect sentient action of the imagined sensation, and may occur as a nerve action, being analogous to the retraction of its foot by a decapitated frog, when its toe is pinched. Illustrations of this kind could, in fact, be multiplied to any extent in support of the proposition, that the indirect nerve-actions of external impressions are, when the latter are felt, at the same time direct or indirect actions of the sensations of those impressions; and that the feeling itself is nothing superfluous[28] in the production of these movements, which the impressions themselves can excite as indirect nerve-actions.

We conclude, therefore, that all nerve-actions of non-conceptional internal impressions can be altogether replaced by sentient actions, that is to say, induced by internal impressions caused by conceptions (Ref. 13, pp. 300-302).

Thus Unzer recognized three categories of movements. The first embraced reflex actions mediated through the spinal cord or ganglia, "purely corporeal and automatic, and incapable of being changed, or induced, or extended, or limited, or directed volitionally"[29] (Ref. 13, p. 201). "These motions do not occur as sentient actions of the external impression" (Ref. 13, p. 304). In the next category were motions which are both sentient and reflected actions, or combinations of the two, permitting a more varied type of response than possible in the more stereotyped reflex actions (Ref. 13, pp. 201, 304). Finally, there were those actions arising solely from the higher passions, from intellectual conceptions and motives and from desires and aversions of the will and their satisfaction; these motions are unmingled with sensational conceptions and are purely cerebral in nature, having no dependence upon external impressions (Ref. 13, p. 305).

Nowhere did Unzer appear to have used the word "reflex" as a noun; although the idea of reflexion was clear enough. Such phrases as "the indirect nerve-action of an external impression" or even "the internal impression derived from a reflected external impression" indicate that Unzer had failed to find the appropriate noun. But while developing Descartes' useful expression, Unzer also conceived another of almost equal usefulness to physiologists. It has already been appreciated how handicapped earlier physiologists had been with the terminology of sensation and volition; even LeGallois at a much later date seemed forced to ascribe both properties to the spinal cord. How could a fiber be named which

[28] Further evidence that even in the earliest days of the reflex it was by no means the stereotyped mechanism it has been supposed to be.

[29] Note again the language of Galen.

mediated either sensation or reflex motion, or combinations or both? Unzer seems to be the first to employ the non-committal expression "afferent" and "efferent" (in their German versions, "aufleitend" and "ableitend").

He might, indeed, have received the clue from Galen's unequivocal demonstration that sensation and volition may be anatomically distinguished. But, he wrote, "neither anatomy or experiment can determine the question; for it is so microscopically minute, as to escape the cognisance of our senses. It was no part of my plan to prove the existence of the two kinds of fibrils. I meditated on certain phenomena, and found that it was absolutely impossible to explain them, except by assuming that afferent and efferent fibrils do exist. The doctrine cannot be absolutely demonstrated; it is but a hypothesis, and I treated it as such" (Ref. 13, note on p. 69).

> The non-conceptional internal impressions will be as little interrupted in their course to the terminal fibril, by external impressions taking the opposite direction, as the conceptional internal impressions, because it is indifferent whether the stimulus be a material idea, or some other irritant in the brain, or on the course of the nerve; and because the apparent reason of this phenomenon, namely, the natural distinction between the afferent and efferent nerve fibrils remains the same. Experiments confirm this doctrine (Ref. 13, pp. 253-254).
>
> Except on the hypothesis of such a difference in the nerve-fibrils, it is very difficult to understand phenomena of this kind. That such phenomena really take place is undoubted; for a limb which has become insensible to all external impressions, and never once manifests nerve-actions, as in the case of a paralysed limb, which never feels nor even contracts when scourged with nettles, may be stimulated to contractions, independently and even in spite of the will, by irritation of the trunk of its nerve; or when some internal agent causes a morbid change in it; and these contractions are manifestly the nerve-actions of a non-conceptional internal impression. Again, there are instances where a limb is not moved either by conceptional internal impressions or by other internal stimuli of the nerves, although it is sensible of external impressions on the terminal nerve-fibrils and nerve-actions are produced thereby (Ref. 13, pp. 254-255).

The writings of Prochaska also served to develop the language of reflex action, although, like Unzer's, they were philosophical rather than experimental, and in a large measure derived from the views of Willis and Unzer. The quotations that follow summarize Prochaska's general concept of the reflex:

> However composite the machine of the nervous system may be, I think it may be divided into three portions, just as its functions are most conveniently arranged in three divisions: namely, in the first place, the animal organs, or the organs of the mental faculty, the cerebrum and cerebellum;

secondly, the general sensorium which appears to consist of the medulla spinalis and medulla oblongata, together with that portion of the medulla of the cerebrum and cerebellum, from which the nerves directly arise; and, thirdly, the nerves distributed from the general sensorium to all parts of the body (Ref. 13, p. 383).

The external impressions which are made on the sensorial nerves are very quickly transmitted along the whole length of the nerves, as far as their origin; and having arrived there, they are reflected by a certain law, and pass on to certain and corresponding motor nerves, through which, being again very quickly transmitted to muscles, they excite certain and definite motions. This part, in which as in a centre the sensorial nerves, as well as the motor nerves meet and communicate, and in which impressions made on the sensorial nerves are reflected on the motor nerves, is designated by a term, now adopted by most physiologists, the *sensorium commune.*

Distinguished men have not agreed as to the seat of the sensorium commune. . . . That the sensorium commune also extends to the medulla spinalis is manifest from the motions exhibited by decapitate animals, which cannot take place without the consentience and intervention of the nerves arising from the medulla spinalis; for the decapitate frog, if pricked, not only withdraws the punctured part, but also creeps and leaps, which cannot be done without the consensus of the sensorial and motor nerves, the seat of which consensus must necessarily be in the medulla spinalis—the remaining portion of the sensorium commune.

The reflexion of sensorial into motor impressions, which takes place in the sensorium commune, is not performed according to mere physical laws, where the angle of reflexion is equal to the angle of incidence, and where the reaction is equal to the action; but that reflexion follows according to certain laws, writ, as it were, by nature on the medullary pulp of the sensorium, which laws we are able to know from their effects only, and in nowise to find out by our reason. The general law, however, by which the sensorium commune reflects sensorial into motor impressions is the preservation of the individual; so that certain motor impressions follow certain external impressions calculated to injure our body, and give rise to movements having this object, namely, that the annoying cause be averted and removed from our body; and *vice versa,* internal or motor impressions follow external or sensorial impressions beneficial to us, giving rise to motions tending to the end that the agreeable condition shall still be maintained.[30]

If a friend brings his finger near to our eyes, although we may be persuaded that no injury is about to be done to us, nevertheless the impression carried along the optic nerve to the sensorium commune is there so reflected upon the nerves devoted to the motion of the eyelids, that the eyelids are involuntarily closed, and prevent the offensive contact of the finger with the eye.[31]

Since the principal function of the sensorium commune thus consists in the reflexion of sensorial impressions into motor, it is to be noted that this reflexion may take place either with consciousness or without consciousness.

But it is a question whether these impressions, in order that they may be reflected, do really travel so far as the sensorium commune, or without

[30] One of the finest statements of the reflex doctrine. Whytt's concept of purposiveness has been extended to include reflexes which maintain an "agreeable condition" as well as those which protect against harm.

[31] No better example exists than this of the constant working and reworking of the basic material of the reflex. Hippocrates, Galen, Descartes, and Whytt discussed this reaction before Prochaska.

taking this long circuit, are reflected nearer in the ganglia, from whence these parts derive many nerves?

But that reflexions of sensorial impressions into motor are effected in the sensorium commune itself while the mind is altogether unconscious, is shown by certain acts remaining in apoplectics derived entirely of consciousness; for they have a strong pulse, breathe strongly, and also raise the hand, and very often unconsciously apply it to the affected part. The sensorium commune also acts independently of consciousness in producing the convulsive movements of epileptics, and also those which are sometimes observed in persons buried in profound sleep, namely, the retractions of pricked or irritated limbs, to say nothing of the motion of the heart and the respiratory acts. To this category also belong all those motions which remain some time in the body of a decapitated man or other animal, and are excited when the trunk, and particularly the medulla spinalis are irritated, which motions certainly take place without consciousness, and are regulated by the remaining portion of the sensorium commune existing in the medulla spinalis. All these actions flow from the organism, and by physical laws peculiar to the sensorium commune; and are, therefore, spontaneous and automatic (Ref. 13, p. 429 *et seq.*).

While Whytt's demonstration of the disappearance of reflex motions following pithing of the decapitate frog might appear to be sufficient proof that all reflexes are mediated in the spinal cord, in reality it proved only that somatic reflexes are so mediated. Although no very clear concept of an *autonomic* reflex had as yet appeared, Haller had suggested a sort of local reflex in the heart as the cause of its coordinated beat, and Unzer, as has been noted, adopted and extended the hypothesis. Prochaska used the same suggestion as an argument that some reflexes may operate through ganglia and plexuses, and it must be recognized that, for the time, it was a completely logical suggestion. Prochaska introduced the thought in answer to two questions serving as the title to the second and third sections of his chapter on the functions of the sensorium commune: "Does every consensus of the nerves take place through the sensorium commune only?" and "Does consensus of the nerves also take place in the ganglia?"

Reviewing the arguments for and against the consensus of nerves in their plexuses, Prochaska gave an affirmative answer: "From which, therefore, I think we may conclude, that although the principal and greatest consensus of nerves takes place in the *sensorium commune,* it is not possible to deny some share in connecting and combining the functions of the nerves to their anastomosing and communicating branches." He agreed also that the ganglia served as reflex centres:

For, if we consider that the minute and invisible nerves disseminated over the internal membrane of the heart and auricles, perceive the stimulus

of the inflowing venous blood, and although they cannot transmit[32] the impression of that stimulus to the *sensorium commune* through the ganglia of the intercostal nerve, yet communicate it to the motor nerves distributed through the substance of the heart and auricles, it follows that there is necessarily a consensus between the sensory nerves distributed on the inner membrane of the heart and the motor nerves disseminated through the substance of the heart and auricles, which must take place either in the ganglia of the intercostal nerve or below them, in the communicating branches or plexuses of nerves. It seems probable, therefore that besides the *sensorium commune,* which we conjecture to be in the *medulla oblongata, medulla spinalis, pons varolii,* and *crura* of the *cerebrum* and *cerebellum,* there are special *sensoria* in the ganglia and plexuses of nerves in which external impressions ascending along nerves are reflected, that need not ascend all the way to the *sensorium commune* to be reflected thence (Ref. 13).

Though Whytt had reported the essential experiments and Unzer and Prochaska had begun the task of writing a new language for the phenomenon, it remained for Marshall Hall to establish the new concept as one of the cornerstones of neurophysiological doctrine. This he achieved not only by his forceful expansion of the terminology of Unzer and Prochaska, but through a careful review and important extension of the experimental evidence of Whytt.

Hall's attention appears first to have been drawn to the subject by the inept formulations of LeGallois, who saw in the motions of a decapitate animal the persistence of sensation and volition in the undamaged spinal cord, and he implied that the designation "reflex" was new and chosen by him. It is almost certain, to judge from statements he made later, that the term was derived from Prochaska, and the event is significant not only from the standpoint of Hall's personality, but as an indication of how little impression the writings of Unzer and Prochaska had made on their contemporaries and immediate successors. Writing "On the reflex function of the medulla oblongata and medulla spinalis," Hall began by describing the limitation of LeGallois' view and then proceeded to state his own:

Many of the phenomena of this principle of action, as they occur in the limbs, have certainly been observed. But, in the first place, this function is by no means confined to the limbs; for, whilst it imparts to each muscle its appropriate tone, and to each system of muscles its appropriate equilibrium or balance, it performs the still more important office of presiding over the orifices and terminations of each of the internal canals in the animal economy, giving to them their due form and actions and, in the

[32] Johnstone proposed (Essay on the use of the ganglions of the nerves. *Philos. Trans.*, 1764, *54*, 177-184) that the ganglia serve to arrest the transmission of the nervous fluid.

second place, in the instances in which the phenomena of this function have been noticed, they have been confounded, as I have stated, with those of sensation and volition; or, if they have been distinguished from these, they have been too indefinitely denominated instinctive, or automatic. I have been compelled, therefore, to adopt some new designation for them, and I shall now give the reasons for my choice of that which is given in the title of this paper.

This property is characterized by being *excited* in its action, and *reflex* in its course; in every instance in which it is exerted, an impression made upon the extremities of certain nerves is conveyed to the medulla oblongata or the medulla spinalis, and is reflected along other nerves to parts adjacent to, or remote from, that which received the impression.

It is by this reflex character that the function to which I have alluded is to be distinguished from every other (Ref. 14, pp. 637-638).

The contributions of Hall to the experimental basis of the reflex were three. First, he extended significantly the category of reflex actions. Blinking, swallowing, sneezing, and vomiting were demonstrated to be reflex in nature through their dependence upon the brain stem or spinal cord. More important, he demonstrated that "tonic" actions were of reflex origin; the peculiar posture of the hibernating hedgehog, the "tone" of the limbs and tail of the decapitated turtle, or the spinal frog may be cited as examples. Still more significant, Hall extended the field of reflexes to include the autonomic system, in the following paragraph:

An interesting experiment demonstrates the powerful influence of the reflex function over the spincter ani of the turtle. If, after the removal of the tail and posterior extremities, with the rectum, and of course with the spinal marrow, water be forced into the intestine, by means of *Read's* Syringe, both the cloaca and the bladder are fully distended before any part of the fluid escapes through the spincter, which it then does on the use of much force only, and by jerks. The event is very different on withdrawing the spinal marrow: the spincter being now relaxed, the water flows through it at once in any easy continuous stream, with the application of little force, and without inducing any distension, even of the cloaca (Ref. 14, p. 645).

Hall seems to have been the first after Galen to make a "spinal" preparation, that is, to cut the spinal cord in an otherwise intact animal to compare the reactions of the central and spinal segments:

The spinal marrow of a frog was divided between the anterior and posterior extremities. It was immediately observed that the head and anterior extremities were moved spontaneously and with design, the respiration being performed as before. But the posterior extremities were not paralyzed: they were drawn upwards, and remained perfectly motionless, indeed, unless stimulated; by the application by any stimulus, they were removed with energy, but once only, and in a manner perfectly peculiar. The stimulus was not felt by the animal, because the head and anterior extremities remained motionless at the time it was applied. Nothing could

be more obvious, and indeed striking, than the difference between the phenomena of the function of sensation and volition in the anterior part of the animal, and those of the reflex function in the posterior: in the former there were spontaneous movements with obvious design; in the latter, the mere effect of stimulus.

The same experiments were made upon the toad; but for some reason, probably anatomical, it does not succeed so uniformly in this animal as in the frog.

The experiment was repeated upon the guinea-pig. The effect was an immediate and total paralysis of sensation and voluntary motion in the posterior extremities: there was no expression of pain when they were pricked, nor was there the slightest indication of a power of spontaneous motion: they were dragged along when the animal moved. They were not unimpressible by stimuli, nor destitute of the power of moving when stimulated: on the contrary, when pinched, they displayed a sort of repeated, hurried motion, altogether peculiar. The power of the sphincters was evidently preserved. In a word, the reflex function remained entire (Ref. 14, pp. 650-651).

Hall was first to speak of the reflex arc:

It appears probable that the facts of this paper may lead to some important additions to our knowledge of anatomy, by inducing an accurate inquiry into the origin, course, connexion, and distribution of the subcutaneous, or submucous, and muscular nerves, which constitute the arcs of the reflex function. There can be no doubt that a system of nerves takes its origin from the lower portion of the spinal marrow, to supply the sphincters and the organs of generation, which may be compared to those which concentre in the medulla oblongata (Ref. 14, p. 663).

Though there were many to point out, as did Mayo,[33] that "movements resulting from stimuli applied, independently of sensation or volition, had long been observed by physicians, and the word reflex only expressed differently what had been previously well known" (Ref. 15), the term was so appropriate, and served to explain so many points of normal and pathological behavior that the concept changed abruptly from one understood

33 Herbert Mayo (*Anatomical and physiological commentaries.* Number II, July 1823. London, Thomas and Underwood, 1823, p. 141) had carefully analyzed the arc of the light reflex; his contribution will be dealt with in detail subsequently. It is not difficult to understand his feelings when he saw Hall claim credit, it seemed to him, simply for giving a new name to an old phenomenon. But it must be admitted that Hall did renew the experimental study of the reflex as well as confirm a nomenclature, and pointed out, far more clearly even than Whytt, the significance of the reflex in clinical neurology. All of these factors, and the energetic championing of the reflex that his contemporaries must have found so trying, combined to establish the doctrine. To apply Osler's criterion, it can be said that before Hall there was no general appreciation of the reflex, while after Hall the reflex was in everyday use in medical discussions throughout the world. It is less easy to understand, unless it be on the grounds of the growing chauvinism of German scientists of the nineteenth century, Pflüger's intemperate and inaccurate assessment, paraphrased as we have seen from Descartes: "was er Wahres bringt, ist alt; was nicht alt, ist nicht wahr" (Pflüger, E. F. W. *Die sensorischen Functionen des Rückenmarkes.* Berlin, Hirschwald, 1853, 14 + 145 pp.

only by a few to a basic axiom of neurophysiological expression.[34] During the century that followed, analysis of behavior in terms of the reflex and examination of the nature of reflex activity became focal points of neurophysiological progress; these will be the subject of subsequent sections.

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[34] The general acceptance of the reflex doctrine was also aided by its adoption by Johannes Müller (Müller, J. *Elements of physiology.* Tr. Wm. Baly, 2d ed. London, Taylor and Walton, 1840-43, 2 vols.). While Müller added little to the experimental basis of the subject, he did much to assemble and organize facts as they were then known.

The Bagnio in London 1648-1725

J. J. KEEVIL*

THE battles of the Civil War were passing into history, King Charles I had only a few more months to live, and the presidential chair at the College of Physicians was occupied by Dr. John Clarke, whose Roundhead sympathies had brought him wealth and preferment.

In 1648 Dr. Peter Chamberlen[1] was also occupied with increasing his fortune. He always presented his interests as if his chief concern were the good of the people, but his protestations were never wholly successful in concealing the fact that his main pursuit was his own advancement. His restless and inventive mind had already led him to attempt the establishment of a company of midwives. His scheme had aroused opposition owing to his wish to make the organisation his personal monopoly; the venture failed and all that survived of his interest in midwifery was the obstetrical forceps with which his name is chiefly associated. His character is to some extent revealed by the fact that, although he rightly claimed for them life-saving qualities, he guarded them jealously as a family secret.

In 1628 he had been admitted, with some hesitation, to the Fellowship of the College, but by 1648 those who supported his election had had much cause to regret it. The plan which he now put forward was nothing less than the establishment of public baths in London. A less self-centered man, or one gifted with greater diplomacy, might have recognised the necessity to secure the College's co-operation before advancing anything so unorthodox. But Dr. Chamberlen addressed himself direct to a higher tribunal: he drew up a petition to both houses of Parliament. Since, however, his aim was once more to secure a personal monopoly, there was perhaps little purpose in his asking the College for its opinion or its support. Admittedly he only requested that this monopoly should be granted for fourteen years, but he was forty-seven years old and that would have covered all reasonable expectations of life.

In his petition Dr. Chamberlen drew Parliament's attention to the use of baths in Turkey, Persia, Germany, Hungary, Denmark,

* London, England.

1 1601-1683.

Sweden, Poland, and Russia, "whose strong, great-bodied, healthful people, beautiful children, and easie births, give no small testimony to the use of Bathes."[2] He anticipated the moral dangers which had throughout the Middle Ages been associated with these continental establishments, and he assured Parliament that "all licentious incivilities will be prevented by severall places and times for men and women: And men to be attended by men, women by women."[2] He asked for a grant from Parliament to help him in the expense of an undertaking which was so directly related to the public interest.

On 31 March 1648, an Ordinance was presented to the Lords for granting him for fourteen years, according to the statute, the "sole making his Baths and Bath stoves."[3] This was read twice and agreed to. It was then sent to the Commons and there, on 22 September 1648, it was "referred to a committee."[4] This Committee of Baths consisted of Sir James Harrington, Colonel Ludlow and Mr. Holland; none of them could claim special knowledge of the subject and not unnaturally they fell back on the device of passing on the responsibility for a decision to others. Members of the Commons of 1648 could not in any case feel much sympathy for a man who in 1643 had claimed privilege as King Charles's physician in order to avoid arrest.[5] They had, however, presented his case very fairly to the College when "desiring their judgements concerning Dr. Chamberlain his Bathes."[6] The ordinance, a copy of which was sent to the College, stated that although "Artificiall Bathes and Bathstoves" had not been used in the Kingdom since "the old Roman times," yet they had been found in other countries to be "of excellent operation both for the preservation of health and recovery of sicknesse, and otherwise very beneficiall for encrease of growth and strength of young and olde." They assured the College that Dr. Peter Chamberlen had "not only been an eyewitnesse of the great usefulnesse of the sayd Bathes and Bathstoves in other countryes and spent much time and travaile and been at great charge in searching out the true way and manner of making the same but hath erected divers of them himself in the Low Countryes for w^ch^ he hath the authority of the State there, and is willing out of his Zeale to the good of his Native Country to undertake at his owne costs and charges the

2 Chamberlen, P. *Annotations in the designe of bathes*, n.d.
3 Lords' Journal, x. 165.
4 Commons' Journal, vi. 276.
5 Lords' Journal, vi. 186.
6 *Annals of the Royal College of Physicians*, iv. fol. 15b-16-17a quoted by J. H. Aveling in *The Chamberlens*, London, 1882.

making of Artificiall Bathes and Bathestoves in this Kingdome." They quoted Dr. Chamberlen as wishing to introduce the measure for the sake of the poor and sick and they desired "to give all just and due encouragement to his undertaking" as one which was "very Hon^{able} in its selfe and profitable to the nation in generall." It was considered that he or his assignees should "have the sole making and erecting" of these baths, their "Cisternes, Waterworks, Engins, Hamacco beds, Hamacco sleds, Hamacco chaires, Hamacco coaches (for the safe and easy setting lying or conveying of weake and sickly persons)" throughout England, Wales, and Ireland, and derive sole benefit therefrom for fourteen years. Certainly Dr. Chamberlen had made a strong case for himself, and so little did the Committee anticipate opposition that the solicitor general, Oliver St. John, had already been instructed to draw up a bill to this effect.

At first the College asked that Dr. Chamberlen should state his case in person before it, but failing in this they opened their reply with the words, since the "Committee is pleased to resolve not to enjoin Dr. Chamberlen to attend the Colledge concerning his design of Bathes they can give no satisfactory answere therein."[7]

Perhaps it was his reluctance to appear before the College which ultimately influenced the Committee to give an adverse decision. Certainly they could not have been convinced by the College's arguments, for the reply had continued: "whereas publick Bathes have been by their abuse the causes in the Greek and Roman states . . . of so much physicall prejudice in effoeminating bodyes and procuring infirmityes, and morall [prejudice] in debauching the manners of the people that in eyther of them upon the coming of the Christians into power they were demolyshed or converted into other uses. And whereas for private use there are in the houses of divers persons of the Kingdome Cradles, tubs, boxes, chaeres Bathes, and Bath stoves in w^{ch} by the help of fumes vapors water oyle etc. according to the prescription of Physitians sweat may be procured, payne asswaged, and all necessary ends of bathing attained." As a consequence the College brushed aside the Continental experience on which Dr. Chamberlen's case rested, concentrated on the fate of Greece and Rome, and asked the Committee and both houses of Parliament so to "regulate" Dr. Chamberlen's design that "none of the aforementioned inconveniences shall

[7] Chamberlen, P. A paper delivered in by Drs Alston, Hamaeus, Bates and Micklethwait . . . together with an answer thereunto. London (1648).

follow." But the real object of their reply is to be found in the request that whatever the decision taken, it should not infringe on the liberty of the physicians in the free practice of their art. In order to lend force to their representations the College sent their report by a delegation, Dr. (later Sir Edward) Alston, Dr. Baldwin Hamey, Dr. George Bate, and Dr. (later Sir John) Micklethwaite appearing on their behalf before the Committee.

Through the selfishness of its promoter a good proposal had aroused the inevitable reaction to defend privilege, and nothing more came of the Chamberlen plan. In many ways it was a tragic outcome. Although the baths might not have saved the 10,000 lives a year, have cured "many (if not all curable) diseases" more safely, certainly, and speedily than could "all Physitians in the world" as their promoter claimed, yet they might have saved this number in the year 1665. It is noteworthy that Dr. Chamberlen urged their incidental value in creating cleanliness and thus as a *means of preventing Plague.*

Dr. Chamberlen did his best to arouse public support and before the close of 1648 had published two pamphlets on the subject: in one[8] he printed the College's report to the Committee "With an Answer thereunto," the other he named a "Vindication of Publick Artificiall Bathes and Bath Stoves." He pointed out that the College had only discussed the abuse of baths, a process to which all good things could be subjected. He declared that their criticism could "as fitly be applyed unto the private Houses, and those accommodations mentioned in the Paper, Yea, to the Excellent and Famous Bathes of Somersetshire."[8] He offered his idea to the State, "should they not wish him to be in charge, in which case perhaps Dr. Grent would "be the best able to serve them."[8] This suggestion was made because Dr. Grent had a bath of his own, but since nothing creditable has ever been recorded of Dr. Grent, it must have proved an equally unpopular proposal. The occasional references in these pamphlets to "Privat-house, or Bawdy-house Bathes," to "Tubbs and Sweating-Cradles," indicate that Chamberlen's idea was not wholly new to London.

But all that came of this pamphleteering was an anonymous reply, evidently written by a Fellow of the College, in which the whole thing was dismissed as the "vexatious importunities of impertinent persons." Chamberlen felt so estranged from the College

[8] *Ibid.*

that he absented himself from their meetings, and his failure to appear on summons led to his dismissal from his Fellowship on 23 November 1649.

* * * * *

Another three-quarters of a century was to pass and George I had occupied the throne for eleven years before London's baths emerged once more from the private obscurity to which the College had relegated them. Unfortunately, they were attended by all the "licentious incivilities" against which Dr. Chamberlen had provided.

The Bagnio lay in the neighbourhood of Piccadilly, the Haymarket, and King Street—the parish of St. James, which already enjoyed the reputation of being the *quartier des vieux garçons.* A society which had moved far towards its climax at Carlton House found all it needed at this remarkable establishment, a fragment of whose account book has been preserved.[9] Under the guise of an innocent enough institution, the Bagnio provided a discreet rendezvous where ladies and gentlemen with reputations to lose could meet gentlemen and ladies who had long since parted company with theirs.

The house was run by a Jacobite so faithful to the memory of King James II, that when Sir Edmund Bacon paid him with a Stuart guinea for being sweated and bathed, the proprietor entered against it in his accounts "Jacobus Secondus which I design to keep as Long I Live 1688." His noble clients included the Dukes of Kent and Somerset, Lord Lonsdale, Lord Ferrers, Lord Bathurst, Lord Sunderland, Lord Charles Hay, Sir James Dalrymple, and the Duke and Duchess of Wharton—the duke and duchess came on different days.

The proprietor graded his charges according to the social status of his customers, a bed and bath for a nobleman costing 10/6, a bed for his valet 2/—, and one for his footman only 1/—, but he varied his charges considerably and might let the Duke of Wharton have two beds for 8/—: the duke was also a Jacobite. He appears to have had two types of clientele: one group was known personally to the proprietor and this was admitted to the more intimate services of the establishment. The other group consisted of strangers whose names were not asked and who simply required a bath, some treatment, or a room in which to read or write for a charge of

9 A waste book, apparently of a Keeper of a Bagnio. P. R. O., London, E. 101/528/19.

4/—; there they could be provided with a fire for 6^d or 1/—, snuff for 2^d, a pennyworth of writing paper, and wax and pens at 2^d. While they waited they could read a newspaper for 2^d, or perhaps be engaged in conversation by the proprietor with a view to deciding whether they should be admitted to his more exclusive group.

From such clients he could have made small profit, but they maintained the reputation of his house as one which provided many amenities. His greatest source of income came from the young rakes and some old ones who began the evening by calling for cards, sold by the dozen, for wine, and for spirits. There was champagne at 6/— a bottle, mountain wine at 2/—, claret at 1/—, or an unspecified white wine for the same price. Cherry brandy cost 3/6, but one could have sixpenny-worth of brandy or of "green usquebaugh" (whisky). Burton ale was 2/— a dram so that the valets and footmen must have had to content themselves with beer at 2^d. Perhaps it was the sack whey at 2/6 or arrack at 1/— which gained in favour as the night advanced. One of the most profitable members of the inner circle was Colonel Hales who usually took two beds and, during the course of the night would order so much arrack punch at 6/— a bowl that his bills for this alone might reach 24/—. Admittedly, there were times when the Colonel had to resign himself to some chicken broth (5/—) and perhaps a little claret, but he never descended to such drinks as citron water (2/—), or those of a pseudo-medicinal quality, the "spaw water 1/6," "milk water 6^d," "Bristoll water 1/—," or even the costly "Hungary water" at 12/— a bottle, and the proprietor saw that no one drank "Playne water" by charging 1/— for it.

There was a simple menu suited to the needs of such a house with its supper parties at which alcohol played so large a part, and its light breakfasts for jaded palates. Patrons could order "mutton steaks 1/—" or "oysters, bread, vinegar and pepper 4/—" with perhaps some "sagoe jelly 1/6." Some might order "tea, sugar, cream 4/6" with bread at 2^d, or "green tea and toast and butter 3/—," or just tea (2/6), or coffee which might cost 1/6 or 2/6. This was expensive, but an attempt by Lord Sunderland to effect a small economy was defeated by charging him 1/— for "drinking his own tea." A man to wait at these meals cost 1/—. Breakfast was usually "bread butter bacon 1/—," or "pocht eggs, butter bread 1/—," or "toast and butter 6^d, Candy 9^d, Jelly 6^d, sugar 6^d," or simply "Chocolett 6^d." Those who stayed the night could get their laundry done for sums varying from 1/— to 1/9. The comfort of the

patrons was most carefully studied: porters would deliver messages for 1/— or only 6^d if the address were nearby, such as York Buildings. They needed no ready money, for the proprietor paid their expenses and charged them up to their accounts: "Paid coach 2/6" "Chase 2/—" or various sums for chairmen. He gave much credit, allowing the bills of such good clients as Colonel Hales to run up to £12, and he would lend from a few shillings to two guineas. Should a gentleman feel a sudden need to look in the fashion, he would buy him hat, gloves, and stockings; he provided a barber (1/—), "pomatum 1^d" and "patches 2^d"; of Lavender water at 6^d Mrs. Walpole bought 4/— worth. His house even served the purpose of a centre for the exchange of messages, such as that "Mr. Bruce was to wait on Lord Londonberry."

Lord Londonberry was not well enough to leave Londonberry House and had to be "cupt att home 10/6," which was twice the sum charged at the Bagnio. Sweating was popular at half a guinea, or it might be combined with bathing and cupping for a guinea. Another treatment which was obtainable was bleeding, but in six months this was only employed twice, one occasion being for the Duchess of Wharton who was "bleeded 1-1-0": whether a surgeon was called in or the shilling barber performed is not recorded.

The Duchess of Wharton tried many methods for dealing with her complaint: "opiatt" was available at 2/6 "a pott" for anyone staying the night, and on one occasion the duchess asked for this; on another she stood a gentleman a bottle of Viper's water. The name "water" seems unsuitable for a rejuvenant which was sold at 5/— and for which there was a very great demand. It is this constant sale of an aphrodisiac which provides the chief indication of the character of the Bagnio. A less oblique reference to what took place there is contained in the memorandum "a woman for . . ." without name or charge.

But the façade of a bathing establishment was well maintained and not only did the nobility and gentry use the baths—"Countess of Denbigh with her sister Both Bathed 1-1-0"—but they sent their retainers there—"Mr. Colvin's Man a bath 5/—," "Lord Cadogan's French gentleman Cupt and bathed 10/6"; these were hot baths, for a cold bath only cost 2/6. The charge for these hot baths would have been more had they not been for commoners: when the Duke of Somerset had a bath it was worth a guinea. Perhaps it was this heavy charge or perhaps no more than the fashion of the time that created a demand for partial cleanliness, for foot baths at 5/— and

"half bathing" at the same price. Wash balls were occasionally bought for 2^{d}, but the rarity of their use suggests that the cleansing was chiefly by hot water or by sitting in rooms to which steam was admitted. Although the steam bath never established itself in England, yet it could already claim some antiquity[10]; that the process was regarded as fatiguing is suggested by the inclusion of a bed in the charge for a hot bath.

The account book, with its brief record of frailty and fashion ends on 10 November 1725, and once more the curtain falls on the privacy of London's baths. This glimpse does, however, suggest that the College might have felt justified for its misgivings, and it seems unlikely that Dr. Chamberlen would have been able to prevent these establishments from following their licentious course, had he been permitted to forward his great plan.

ACKNOWLEDGMENT

My thanks are due Mr. K. Timings, Public Record Office, who drew my attention to the Bagnio accounts, and to Mr. M. F. Bond, Record Office, House of Lords.

[10] One Tudor house at least still possesses its original steam bathroom, and a Turkish bath was opened in Bagnio (later Bath) Street, London, in 1679.

The Influence of the Social Environment on the Style of Pathological Illustration

EDGAR GOLDSCHMID*

WHEN Joseph the Second, the Roman Emperor of the German nation, became interested in anatomical preparations, he ordered from Florence a number of wax figures which cost him twenty thousand florins, and on their completion he had them exhibited at his museum in Vienna. There they could be seen from the end of the eighteenth century onwards, and they constitute one of the glories of the Josephinum.

About fifty years ago a booth-keeper at a fair became bankrupt and had to sell his stock-in-trade. Among this was an anatomical wax figure, consisting of a torso and some extra organs, and this was sold to the Museum of Zoology at Lausanne. There it was enclosed in a show case. It is called "Le Grand Macchabée," and as it was not considered fit for young or non-professional eyes, the figure was enclosed in double coverings and eventually totally forgotten.

If, a hundred years ago, a wealthy connoisseur wanted to obtain some information about morbid anatomy, he might have purchased —if he could have found a copy—a book which is rich in pictures, the *Praxis medico-chirurgica* by Auvert. Having got it, he would have locked it up in his library, since he would probably suppose that this was a book too expensive to be pushed about, and which children should not see. Nowadays, any student who wants to learn from anatomical illustrations something more about pathology than he is obliged to do for the requirements of his course may find a copy of Bollinger's *Atlas und Grundriss der Pathologischen Anatomie* on a bookstall in the market place for a few shillings; and not only he but his friends also will enjoy this work and find that it enlarges the scope of their knowledge. As John Bell emphasises, it is better to study detail from a true drawing than to read the most detailed textbook about the subject. To adapt a text from the book of Proverbs, a good book is as "The blessing of the Lord, it maketh rich, and he addeth no sorrow with it" (X. 22).

It is very interesting to study the influence of the social surroundings in effecting changes in the style of pathological illustration.

*Lausanne, Switzerland

No date can be fixed for the appearance of the first illustration of a subject drawn from morbid anatomy, and indeed no date can be fixed for the birth of morbid anatomy itself. It is customary to refer to Morgagni as the father of the subject, and to Théophile Bonet of Geneva as its grandfather. That being the case, how are we then to designate the other ancestors which are known to us? It seems to me that before we consider the social and other environments, we should know something of the *dramatis personae* themselves.

I should like to begin by suggesting that morbid anatomy is apparently an older subject than normal anatomy, because there has always been a practical need to ascertain the character of morbid alterations. This simply means the observation of conditions as they exist. It was a far cry from that to the beginning of the scientific aspect of the subject—that is, normal anatomy—since a desire to get a thing done does not imply the existence of, or even the urge for, a scientific theory. This resembles somewhat the difference between helping and caring for a patient on the one hand, and of trying to find out why he is ill on the other.

As an example may I remind you of many passages in the Bible about all sorts of diseases, and also of the strict rules which prohibited the admission of deformed persons directly to the service held by the Priest. There was nothing to indicate how or why there was discrimination against these persons. I would remind you also of the fact that the making of pictures of living creatures was prohibited. Then there is the tale of Job, afflicted and in rags, not being scorned, but honoured and cared for by everyone except his wife. There is, however, a gap of a century between the dates of these two books, Leviticus and the book of Job.

In medieval manuscripts there are numerous illustrations of sick people undergoing treatment and, as far as they can be made out from the small scale of the illustrations, the conditions shown would seem to be, in a vague sense, wounds and deformities as seen through the eyes of a physician—that is as a monk who did the illumination saw them. These illustrations were apparently made for secular clerical readers, as educated persons were only to be found in that group of society. The little pure anatomy which was depicted was entirely imaginative.

Later on, in miniatures as well as in the early woodcuts, there is the atmosphere of the old universities which, too, is purely clerical. The presence of these clerics at an autopsy or a dissection

must have been the reason which emboldened the artist to depict such matters for the general public.

This supposed public, of what did it consist? If anyone will take the trouble to compare the different woodcuts dealing with the same autopsy seen in the numerous editions of the work *De proprietate rerum* by Bartholomaeus Anglicus, he will see that, so far as any decision can be made from the appearance, bearing, and dress of the persons represented, they consist in the first place of persons who are obviously academical and clerical, forming some kind of upper class, and in the second place of the underlings who were employed to help with the rough work. No members of the general public appeared to be present. It can be assumed, therefore, that these works were not produced for the edification and instruction of the general public. They were just 'Epsilons,' as Aldous Huxley would say.

Turning now to the illustration of an autopsy in a manuscript in the Ashmolean at Oxford, we find that, though the picture illustrates the procedure as it was practised, quite a different scene is presented. The illustration shows that during the autopsy the operator is being disturbed by persons who are apparently of his own class. They do not appear to be members of the public, and they look very like persons in authority. The same year, 1493, produced the famous dissection scene in the *Fasciculus* of Ketham. In this the onlookers are a very different looking lot, and they certainly could not be confused with the underlings who are present. A change in society seems to have occurred in the middle of the sixteenth century, where we find a slight modification of the famous woodcut of a dissection scene out of Ketham's *Fasciculus* in the 1556 Paris edition of honest old Bartholomaeus Anglicus' *De proprietate rerum*. Instead of monks and stern-looking figures, there are the well-known academical gentlemen with their subordinates at work.

From the publication of the frontispiece of the *Fabrica* of Vesalius in 1543 until the end of the sixteenth century, we find a real public present—a public with very different claims and pretensions. There is no need to go into detail about this much discussed titlepage and the types of persons represented in it. About this time, however, collections of clinical cases in the form of "dissertations" and volumes of "letters" were becoming popular, and some of these included what might be called pathological illustrations. These were really portrayals of morbid anatomy. The wood blocks were

often beautifully cut, and the illustrations themselves were designed to be of use to the medical profession, both physicians and surgeons. A distinction is to be made between these two groups which constituted the profession, since their background and training were very different. For example, it is helpful to bear in mind the abyss which existed between Ambroise Paré and the other surgeons of his time, who were in a way his subordinates. If some of these men were able to understand an illustration, it is more than one could expect of all of them. But Paré himself was trying his whole life to rise out of the social grade into which he had been born. He was always wanting to become a gentleman, although he had all sorts of bourgeois habits and ideas. He had a small collection of pathological specimens, hence his woodcuts are quite first-rate, and his own portrait is as well presented—*soigné*—as possible. It is not difficult to imagine him trying to please people of the class into which he wanted to rise. For that we should not call him a snob, but we ought rather to admire him for his aspirations. He had to reckon with many types of people in his environment—surgeons as well as learned physicians, the royal court, as well as the upper classes and the common people. All these had certain beliefs, which he of course partly shared, and which he certainly had to bear in mind. This seems to explain the pictures of miraculous beings and prodigies which are found in his works and which are now only a matter of passing interest.

About sixty years after the time of Paré we meet another great surgeon, Fabricius Hildanus, a German who lived mostly in Switzerland. We can now state that the prodigies had disappeared, and the illustrations are straight-forward preparations of morbid anatomy such as a surgeon might produce any day in the course of his operative work. Fabricius was physician of the town (*Stadtarzt*). His public were not only physicians and surgeons, but also educated people such as naturalists who knew what they were doing. As Paré had published in French, Fabricius published in German, his own native tongue.

At the end of the seventeenth century we have the work of Bonet, very learned and polished. Then in the early eighteenth century Morgagni published illustrations of fine quality which were drawn for learned readers who would not be satisfied with approximate delineations. Anything approaching the miraculous is completely absent from these plates—there is only the riddle left in the vignette of the title-page. But we must remember that lesser writers,

French, German, and Italian, still gave examples of this tendency. But during this period many dissertations and letters were published, each containing one or two plates, each done with the utmost accuracy, and even showing real beauty.

Before we discuss the great atlases which appeared in the latter part of the eighteenth century mention must be made of works on normal and morbid anatomy, in which cases it is difficult to say for what type of reader they were made. As examples we may mention Gautier d'Agoty and Gamelin. Gamelin is only presenting normal anatomy. But who in the world would think of learning anatomy from these figures which, though showing good draftsmanship, are violently distorted and always suggest that they were screaming and kicking? Apparently, there existed persons who appreciated that kind of thing and were wealthy enough to pay for it. And those frightful life-size engravings printed in four colours by Gautier père, who called himself "Anatomiste du Roy"! Garrison pretends to be delighted with these illustrations. But think of these half-dissected women, with their bellies open and visibly flirting with their public.*

Gautier's book on *Maladies Vénériennes*, a pathological work, is in the same style. Who were the people who induced him to publish these things in that way, and who paid the extravagant prices he asked for them?

Gautier published between 1755 and 1775, just before the French Revolution. Gamelin published in 1779. Can we see here, even in such a remote subject as anatomy, a foreshadowing of the change that was to take place in the minds of the people? The public for them must have existed, for otherwise the author would not have found a publisher, since publishers are business men and not philanthropists. But can one imagine the people who made up eighteenth century society as we know them from their books and correspondence and also from what has been written about them? Can one imagine this public buying and reading such books and enjoying such pictures? There is of course no accounting for taste. One day recently, when showing my books to a very distinguished historian of anatomy, he told me that he wanted to see everything I had. He then added, "but don't show me any of your horrors."

*The Wellcome Historical Medical Museum has a number of these illustrations by Gautier père, put together to form figures in life size, whereas the ordinary collector is quite satisfied to hide these plates in their book or in portfolios.

Fig. 1. Fifteenth century miniature of extramural dissection. Reproduced from Streeter and Singer in Sudhoff's *Festschrift*, 1924.

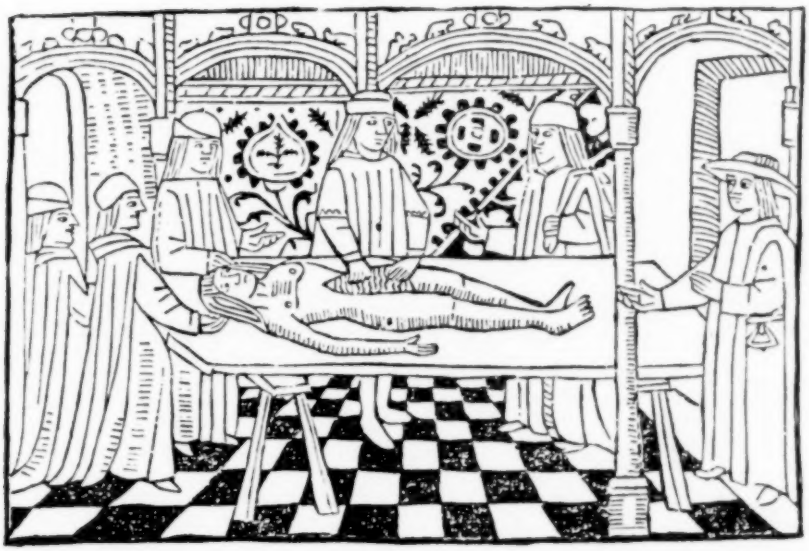

Fig. 2. Woodcut from Bartholomaeus Anglicus, *De proprietate rerum*, 1493.

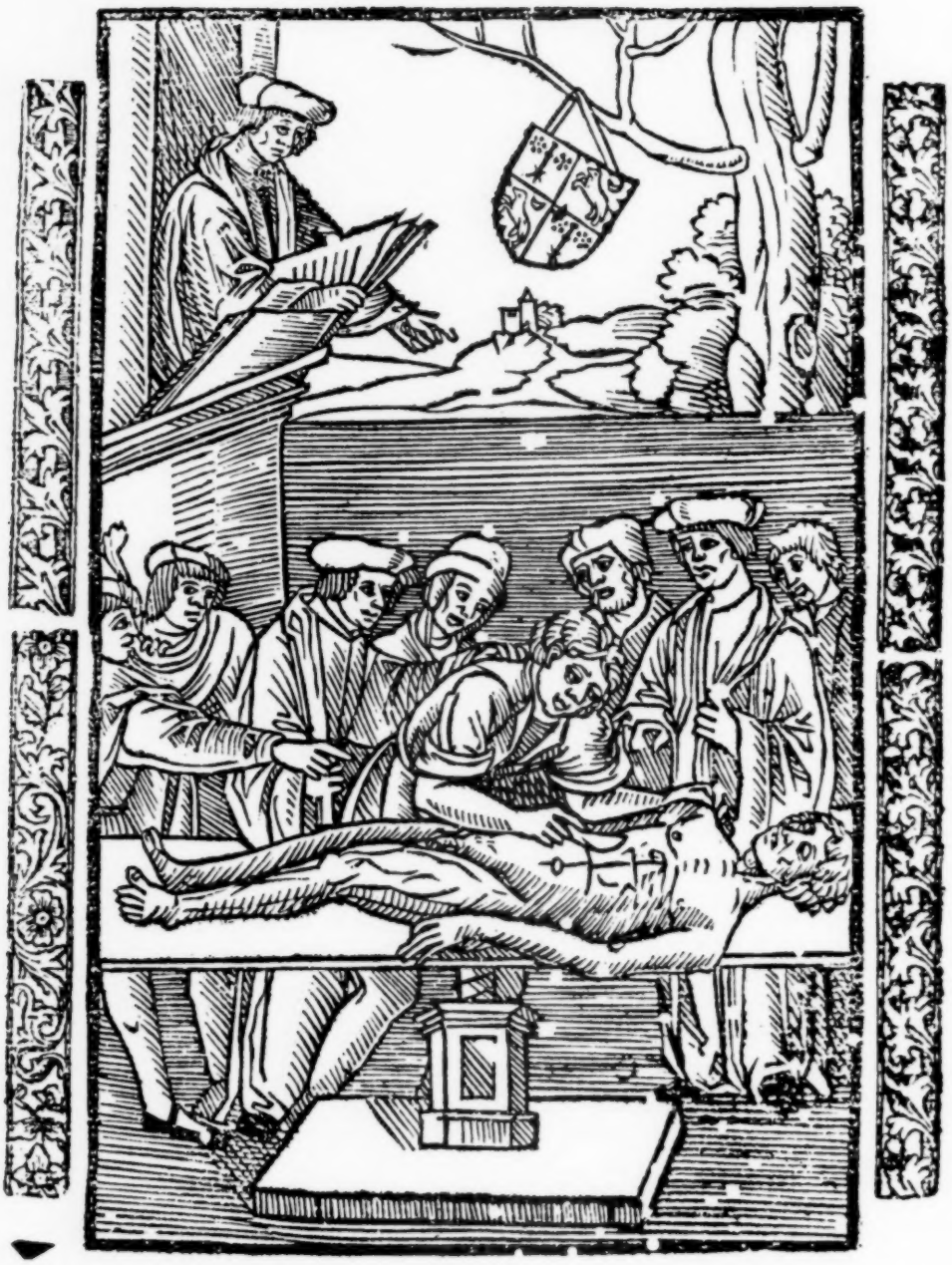

Fig. 3. A plagiarism after the famous woodcut in Ketham's *Fasciculus medicinae* (Venice, 1493) in Bartholomaeus Anglicus (Paris edition of 1556).

Fig. 4. Title-page of the *Encheiridium anatomicum* of Jean Riolan, *fils* (Leiden, 1649), with portraits of anatomists.

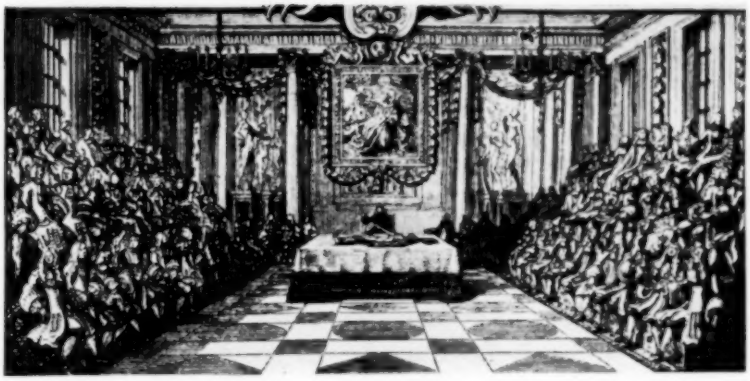

Fig. 5. A seventeenth century *Séance d'anatomie*, published by Hoffbauer, 'Paris à travers les âges.' In Paul Lacroix's *Le XVII^e siècle, lettres, sciences et arts. France, 1590-1700.* Paris, 1882.

Fig. 6. William Hogarth's "Stages of Cruelty," No. 4. 1750.

Fig. 7. Phantastic anatomical display, from Jacques Gamelin's *Nouveau recueil d'ostéologie et de myologie*, etc. Toulouse, 1799.

I regret to mention another fact, namely, the disinclination of the average practitioner to buy books, or even to read them or to look at them. Of course some exception must be made of books of a so-called practicable nature. In this connection we might consider what William Osler says of the average reading matter of the physician—what he calls the bedside library for medical students. I am quite sure that there are some young enthusiasts who follow his advice; but are they sufficiently numerous to form the representative class of the medical profession? They certainly do not form a majority, nor do they constitute the average type of professional man. They are simply a few selected Alphas, and this history will prove.

But to return to Gamelin. His was the epoch of large collections. For example, Sandifort's *Museum anatomicum* appeared in Holland in four large royal folio volumes which dealt with both normal and morbid anatomy. These volumes had a public, because at that time they represented what today would be covered by the pathological museum and practical demonstrations. Nowadays we can boast that everywhere there are institutes and collections for the use of students, but one hundred and fifty years ago these things did not exist to a great extent. The work entitled *A Series of Engravings* by Matthew Baillie would have constituted the first textbook of morbid anatomy for students if it had not been so expensive. The textbook of Aloys Vetter, published about the same time, was apparently excellent, and was moreover cheap and handy in size. It has disappeared without leaving a trace. We must assume that Baillie's highly praised work had a selected public which had sufficient means to buy expensive literature. It is a pleasant thought, indeed, to picture the famous English physicians of the time—such as John Coakley Lettsom and his friends—reading and enjoying this book—but let us not forget the Quaker Fothergill's making £5000 a year and Lettsom as much as £2000. One wonders, however, whether a practising physician or surgeon of the period had sufficient time or money to make himself acquainted with these splendid engravings, which are so much admired even to the present day. Let it not be thought that I despise in any way these honest, hard-working practitioners of their art. But let me remind you of Sir Astley Cooper, dissecting and operating, lecturing and seeing patients, writing and publishing his works, working from six in the morning until midnight "with forty winks of sleep

during the day," but neither thinking of opening other people's books nor quoting any author as a reference.

I ought to say something of those quite outstanding drawings and etchings of normal and morbid anatomy and surgery which the two brothers, John and Charles Bell, left to posterity in addition to their sketches of Italian scenery. They were sons of the manse, and had no money. They rose in hostile surroundings, and Sir Charles eventually became something of a dandy. Books like the *Essay on the Anatomy and Philosophy of Expressions* and *The Hand,* with beautiful drawings by Sir Charles Bell himself, ran into seven editions during the period which ended fifty years after his death. His collection was bought by the Royal College of Surgeons of Edinburgh. John became the most sought-after surgeon in Scotland, while his pupil John Lizars followed in his footsteps. But of this more later.

These authors certainly had their public, for besides the English editions there were translations into other languages, though I do not see them quoted as frequently nowadays as I would have thought they might be. Most of these, even the books published in small and relatively cheap editions, were too expensive, at least for the Continental public. So Robert von Froriep at Weimar translated and published parts of them in cheap editions as well as the works of other authors, and discovered a medical public of average means who would buy them. His *Klinische Kupfertafeln,* and the *Chirurgische Kupfertafeln* which were designed to illustrate the *Handbook of Surgery* by Samuel Cooper, the nephew of Sir Astley, found a wide circulation, though each work was published with 83 and 482 plates respectively.

At this point, I cannot refrain from quoting *La Medicina Pittoresca* by Filoteo d'Ippolito, an obscure professor in Naples University. The lithography in these four quarto volumes is frightful. His was apparently a public of small means and not too profound learning. The book, a compilation drawn from the works of Bayle and others, proved so useful to practitioners and the average reader that it has now become practically unobtainable. There is only one possible description of this type of book—cheap and nasty. I am sorry to confess my absolute ignorance of the author's life, as not even the University of Naples can give me any further particulars.

Let us come to Jean Alibert, baron Alibert. He wrote excellent, dignified French. His writings are full of ideas but are sometimes

rather pompous. As a clinical teacher he enthralled his audiences. He was beloved by his numerous patients and the "Society." His *Description des Maladies de la Peau* (later entitled *Clinique de l'Hôpital St.-Louis*), his *Dermatoses* and his *Nosologie Naturelle* were all published between 1806 and 1838 and were beautifully produced. They are of the highest interest and were greatly admired. Even now they are a treasure for the student as well as for every lover of fine medical books. At the time nobody bought them since they were far too expensive. Of course cheap reprints and imitations appeared. Alibert's Graeco-Latin nomenclature was supposed to be too difficult, but other authors were not easier to understand. He employed the best artists available in Paris, such as Moreau-Valvile, Tresca and others. The illustrations are hand-coloured aquatints—a technique which is as beautiful as it is expensive. All the books appeared in quarto, folio, or even royal folio. We are told that the author spent more than one hundred thousand gold francs on his books. We know his personal taste, too, as we are told about the original flower paintings by Redouté which adorn his house; and we know also that the guests whom he invited to his famous dinner parties were very select. Besides being a professor of dermatology, Alibert held a chair of botany and was a practitioner in the town. Like Cruveilhier, he would climb to the fifth or sixth floor of a house to see a patient. But he was also physician-in-ordinary to several kings.

A contemporary of Alibert was Jan Bleuland of Utrecht, a man of vast learning, who occupied four medical chairs. He left us first-rate drawings in coloured aquatints dealing with anatomical and pathological subjects. These were splendidly produced, but he had to publish them with the assistance of grants from the government, as there was apparently no public demand for these highly finished illustrations of scientific subjects. Bleuland was himself a connoisseur and collector. His anatomical collection had already been acquired by the Government some time before his death, and on that event his collection of pictures was sold and fetched high prices. It seems to me that from the point of view of his medical works he had no public at all, and his influence on the medical profession of his time is difficult to assess. I have only once found any personal reference to him. It was when Sir Astley Cooper, who was traveling on the Continent, was taken over Bleuland's museum by Bleuland's son.

In dealing with this time, around the year 1820, mention should be made of the *System of Anatomical Plates* by John Lizars. These contain some very good coloured engravings of the diseases of the brain and meninges and (a rare event at this period) a reliable illustration of the thoracic duct. Lizars was a pupil and follower of the brothers Bell. He became professor of anatomy and surgery at Edinburgh and an opponent of Syme. His thin, tall volume on *Tumours of the Ovary* contains two of the finest coloured engravings which have ever been made. His brother W. H. Lizars worked for him as a draftsman and engraver. This author is but rarely quoted; he practised his profession and served as a connecting link between contending factions.

A little later than Lizars we come to Jean Cruveilhier, the best known and most important producer of illustrations on morbid anatomy. He came from a clerical family and had no means at all. He was aided by his bishop and by Dupuytren in establishing a museum of morbid anatomy. He held the chair of this subject at Paris and all his life was also a practitioner in that city and saw patients in their own homes until he died in advanced years. The two large and heavy volumes of his great work appeared between 1829 and 1843 and were sold for four hundred and fifty gold francs. They were highly praised and very successful; but they never sold out. There is a cheaper Italian edition (but this remains, so to speak, totally unknown), and a German translation was begun. So Cruveilhier, too, published for himself and the use of his colleagues —for it is difficult to believe that practitioners ever bought this book. The list of subscribers is known.* His technique was no longer that of etching and engraving. It was the newly invented lithograph coloured by hand; this later degenerated into stenciling.

Before the new type of mechanical printing conquered the market and made the illustrated medical book accessible to everybody, there were two more publications of the finest type which had, however, by then become old-fashioned. About 1830 there was working a rather particular man called Robert Hooper, an

*Cruveilhier's editors give evidence that about 409 copies were distributed: 150 copies went to booksellers (35 per cent) representing 78 different firms; 79 copies (19 per cent) were taken by physicians, 24 by surgeons, 18 by university professors or head physicians of hospitals. Individual booksellers subscribed for as many as 26 or 15 copies, three took 13 copies each. In Lebert's book, there is no final figure given, and the lists do not allow one to single out the different purchasers. But we may note 74 booksellers with 149 copies, 55 physicians, 6 surgeons, 29 university professors or head doctors of hospitals, 14 persons without definite indication of their profession or social status. Two booksellers subscribed to 30 copies each, one to 17, and one to 13 copies.

excellent and well-known physician and writer, author of several small folio volumes which contained first-rate plates dealing with the morbid anatomy of the uterus and the brain. He had to act as his own publisher and bookseller. I do not know for what public he wrote. His books scarcely ever come on the market, and neither Garrison nor Sudhoff thought of mentioning his works.

During that fertile period between 1830 and 1860 there even appeared a book by a man practising in Moscow. It is a large volume in royal folio and it contains a great number of splendid illustrations of morbid anatomy and of surgery. The book was luxuriously produced in 1851 by Baillière, the famous Paris publisher. The work is the *Selecta praxis medico-chirurgicae &c.* by Alexander Auvert. Auvert was a Frenchman, who studied under the younger Lobstein at Strasbourg. He practised in Moscow and was surgeon-in-chief to the Clinique Thérapeutique. He started his work in 1848. The drawings are in the finest style and were etched in the best manner of the time by the famous Paris artists who have been mentioned above and were hand-coloured. Besides making use of the ordinary process, Auvert also employed the newly invented method which consisted in modelling in plaster-cardboard after plaster casts had been previously made. This method, which had been introduced by Dr. Félix Thibert at Paris, had been highly praised by Cruveilhier himself. The inventor made a museum of his models and published a catalogue; but the whole thing was soon forgotten. A few specimens are in the Musée Dupuytren at Paris. This was not a method for small purses, nor was the book one that the ordinary practitioner could have bought. I have not been able to ascertain anything about the author, except that he was able to secure the services of Ambroise Tardieu in Paris to supervise the production of the book. The price was five hundred gold francs. The expense of production was borne by Count Stroganoff, the Secretary of State. As there was, accordingly, no necessity for the author to economise in production, he was able to show each patient at three different times, before, during, and after treatment. This work was apparently not meant for the ordinary practitioner of the "tiers état" and it would be difficult to imagine any practitioner obtaining it at his own expense. It is very rare even where the largest libraries are concerned. There is a copy somewhere in the United States. It is the same copy which twenty years ago, after much trouble, was found for me but was

then inadvertently sold to someone in America. I suspected that Krumbhaar had got it and asked if that was the case. He denied responsibility, but did not succeed in finding out who had purchased it and had kept it hidden away. You will understand that I had no hesitation in uttering the curse of Bishop Ernulphus on the person responsibile. You might also find it interesting to look at the relevant passage in Sterne's *Tristram Shandy* (Chap. XI, Bk. III).

The other book of outstanding merit during this period is the work on morbid anatomy (*Traité . . . description . . . et iconographie . . .*) by Hermann Lebert, a German practitioner of medicine and surgery who was also a botanist and zoological investigator. He worked in Switzerland and Paris and was later professor of clinical medicine in Zurich and Breslau. I do not know how he worked or how he was able to obtain the material which he used. Neither can I imagine for what public he wrote, nor how he found time to compress so much into his life. He says that by practising in Paris he earned all the money that was necessary to produce his expensive publications, but the labour of practising his profession gave him no leisure for original investigations. In 1852 therefore he accepted the chair of clinical medicine at Zurich, and in 1859 the corresponding chair at Breslau. Lebert was an excellent practitioner much beloved by his patients. One of these, the widow of a colleague of Lebert, told me this herself. "But," she said, "he was very ugly, and indeed the only person who was more ugly than he was his wife." Lebert's most important work appeared between 1857 and 1861. It was published in four royal folio volumes by Baillière of Paris, as were most of his other large and costly books. Two of the four volumes form an atlas with explanatory text. The plates are engraved on copper and hand-coloured. They are most exact and deal both with gross anatomy and histology. As in the case of Auvert's book, the illustrations were made by the best artists then available in Paris and are very fine. The text, too, is excellent and in advance of its time.

The period of decadence, judged from the artistic aspect, was not far off, since modern technical methods of reproduction depending on the invention of photography were soon to be introduced. These new methods changed not only the appearance of the illustrations, but also the cost of the work to the purchaser. As a result, there was also a change in the class of purchaser. About

fifty years ago the average student was well able to obtain at little cost illustrations not only of normal and morbid anatomy, but also those dealing with clinical subjects. Such illustrations could be bought for as little as ten francs each.

Just as in the earlier part of the nineteenth century it had been a German—Froriep of Weimar—who had attempted to introduce inexpensive, illustrated textbooks, it was again a German firm of publishers, Lehmann of Munich, which introduced the series of small and inexpensive volumes, the title of each of which began with the words "Atlas und Grundriss." This series gave the average student and practitioner a chance to increase his knowledge by acquiring illustrated books at prices which he could afford. This enterprise was a real attempt to popularise scientific knowledge. It was highly praiseworthy, even though we may deplore the falling off in artistic standards, and the final and inevitable ruin of all artists and craftsmen who up to then had been so successfully employed in producing the old type of illustration.

Summing up, it may be said that, even in early manuscripts, illustrations dealing with pathological subjects have been found, together with those dealing with anatomy and surgery, and also as illustrations of autopsies. These illustrations were designed for the use of clerics. We followed their evolution, through the middle ages and through the university circles of the sixteenth and seventeenth centuries, during which they became independent, as it were, since the persons for whom they were designed changed from clerics to medical men proper. Finally, at the time of the French Revolution, the Directory, and the Empire, when the rich countries were having their financial ups and downs, we saw these illustrations develop until they reached their climax in artistic evolution during the period of the French Restoration. In the course of their development the modest little miniature had evolved through the stage of the small woodcut, until it became a real work of art by the finest artists of the time. Such illustrations were engraved and then coloured by hand. The final stage in the evolution was the introduction of modern mechanical methods, in which quality was replaced by quantity, and the work of the artist and craftsman was replaced by technical processes. The time had now arrived when the average student was enabled to purchase scientific works which had formerly been inaccessible to those with small purses.

The study of such a small detail of the production of the medical book has involved us in a lengthy journey. As we began by quoting the Proverbs, we may end with the words of Ecclesiastes: "There is no new thing under the sun."

ALIBERT, JEAN LOUIS	1766-1837	GAUTIER D'AGOTY, J.-FAB.	1717-1786
AUVERT, ALEXANDER	?-1865	HOOPER, ROBERT	1773-1835
BAILLIE, MATTHEW	1761-1823	D'IPPOLITO, FILOTEO	(1839)
BARTHOLOMAEUS ANGLICUS	(1240)	JOHANNES VON KETHAM	(1491)
BAYLE, G.-LAURENT	1774-1816	LEBERT, HERMANN	1813-1878
BELL, SIR CHARLES	1774-1842	LETTSOM, JOHN COAKLEY	1744-1815
BELL, JOHN	1763-1820	LIZARS, JOHN	1783-1860
BLEULAND, JAN	1756-1838	LIZARS, W. H.	1788-1859
BOLLINGER, OTTO V.	1843-1909	MORGAGNI, GIO. BATTISTA	1682-1771
BONET, THÉOPHILE	1620-1689	OSLER, SIR WILLIAM	1843-1919
COOPER, SIR ASTLEY P.	1768-1841	PARÉ, AMBROISE	1510-1590
COOPER, SAMUEL	1780-1848	SANDIFORT, EDUARD	1742-1817
CRUVEILHIER, LÉON J.-BPT.	1791-1874	STERNE, LAURENCE	1713-1768
DUPUYTREN, GUILLAUME	1777-1835	STROGANOFF, COUNT SERGEJ	1794-1882
ERNULPHUS, BISHOP	1040-1124	SYME, SIR JAMES	1799-1870
FABRICIUS HILDANUS	1560-1624	TARDIEU, AMBROISE	1788-1844
FRORIEP, ROBERT V.	1804-1861	THIBERT, FÉLIX	(1839)
GAMELIN, JACQUES	1739-1803	VETTER, ALOYS RUDOLPH	1765-1806

The School of the Hospital de la Charité in the History of Hypnosis*

JEROME M. SCHNECK‡

DURING the course of studies in hypnosis, the writer encountered mention of the "School of the Hospital de la Charité." This appeared to be of interest and worthy at least of some further attention in view of the fact that no such "School" had been commented on in numerous books and manuscripts previously examined. Although the actual significance of this hypnosis group probably cannot be determined as yet, the presentation of preliminary material offers the opportunity for further elaboration at a later date.

The School de la Charité is discussed by one of its representatives, Dr. Foveau de Courmelles, in his book, *Hypnotism*,[1] published in the English translation by Laura Ensor in 1891. The volume is illustrated with forty-two vignettes by Laurent-Gsell, and a number of these are of historical interest. In regard to himself, the author informs us about a few things in his book. In the preface he mentions having been a medical student in the Paris hospitals. Later, in 1889, he served as Vice-President of the International Magnetic Congress. Also, ". . . I had access to the best authorities, and have been able personally to test most of the assertions which have been put forward, to effectuate some cures, and to form an exact opinion on the different phenomena. I have interrogated the much decried magnetizer, the humble practitioner and the learned academician, and the book I now offer to the public is the result of my numerous observations and interrogations." He comments additionally on the question of free will which greatly concerns him and which plays an important rôle in the volume.

De Courmelles focusses attention specifically on the group at the Charité as well as at the Salpêtrière and at Nancy. He mentions that he is one of the principal writers on this subject and includes himself among the pupils of Luys. Others of the Charité School

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‡New York, New York.

1 De Courmelles, F. *Hypnotism*. London, George Routledge and Sons, Ltd., 1891. (Translation by Laura Ensor.)

are Bottey, L. R. Regnier, and de Grandchamps. Luys was the chief figure and both he and De Courmelles will be dealt with in this paper. As the principal writers of the School of Salpêtrière, the author mentions Charcot, Binet, Féré, Gilles de la Tourette, and Babinski. In connection with the Nancy School he refers to Liébeault, Bernheim, Beaunis, and Liégeois. De Courmelles includes in this volume the fact that he is author of a book called, *Le Magnétisme devant la loi.*

Three chapter headings in the volume, *Hypnotism,* carry the names of the schools—Salpêtrière, Nancy, and De la Charité. A brief comment about the Salpêtrière and Nancy groups might be in order for the purpose of providing historical perspective. The Salpêtrière School attained status through its leader Charcot who, during the 1880's especially, was involved in hypnotic experimentation. Also known as the School of Paris, the Charcot group, referred to at times as the physicalists, were particularly interested in hypnotic phenomena which they felt were based on physical stimulation primarily and which were neuroanatomically and neurophysiologically significant even though the neurophysiological aspects were not too well understood. Since the phenomena appeared most conspicuously in the group of patients who were grossly hysterical, such patients received considerable attention, and it was felt that the hypnotic phenomena themselves were consistent with the pathological nature of the subjects studied. The less outstanding hypnotic manifestations in the less obviously hysterical patients received a smaller degree of attention and concern. When it was claimed by others that many normal people were hypnotizable, the Charcot group wondered about the pathological characteristics of these people which might have been overlooked and which might account for any hypnotic phenomena being elicited at all. In keeping with the neuroanatomical orientation of the Salpêtrière School, stress was placed on three phases of hypnosis observed in the subjects experimented upon—the lethargic, cataleptic, and somnambulistic stages. Muscular contractions elicited in the first group, as a result of pressure on appropriate nerves and muscles resulting in muscle contractions consistent anatomically with nerve distributions, were dealt with frequently. Also, several patients, although not all, were believed to possess auditory anaesthesia in this stage. By opening the eyes of a hypnotically lethargic subject, the cataleptic stage was automatically introduced, although it could be induced initially with certain sudden

forceful stimuli such as the sound of the Chinese gong which constituted part of the Salpêtrière apparatus. Cataleptic rigidities were studied in this second stage. Finally, a physical stimulus such as rubbing the forehead of the subject could introduce the somnambulistic stage during which considerable physical and mental activity ensued in contrast with the more rigid and automaton-like appearance found in the second stage. Magnets played an important rôle in the work of this group because it was felt that they could transfer phenomena from one side of the body to the other, for example, by application of these magnets. To assume that the Salpêtrière group had little awareness of things psychological would be incorrect, as can be seen by reference to the book by Binet and Féré on *Animal Magnetism*.[2] Likewise, implications to the effect that attempts to control their experiments were not made are also incorrect. That the results obtained in certain instances have not withstood the test of time is of course true.

Under the leadership of the country medical practitioner Liébeault and the professor Bernheim,[3] the Nancy School stressed largely the psychological aspects of hypnosis from the point of view of its implication in induction procedure and the significance of the hypnotic phenomena elicited. The stages propounded by Charcot, even in their most clear-cut manifestations among select, grossly hysterical patients, were felt by the Liébeault—Bernheim faction to be based on suggestions offered the subjects, unconsciously perhaps, by the experimenters despite, as may be seen in the Binet-Féré volume, assertions to the effect that this possibility had been taken into consideration and especially avoided. Furthermore, the existence of hypnosis and hypnotic phenomena within the realm of normality rather than as pathological manifestations and the claim that susceptibility to hypnosis was widespread among a normal population were tenets of the Nancy School. In addition, the therapeutic applications of hypnosis were stressed in contrast to the largely experimental interests of the Salpêtrière faction. The concept of "suggestion" in a rather broad sense was heavily emphasized, and the Nancy group is also referred to as the Suggestionists. An additional point to be made here, with reference again to the Binet-Féré volume, is that the Charcot group apparently recognized the fact that suggestive influences could reproduce the

[2] Binet, A. and Féré, C. *Animal magnetism*. New York, D. Appleton and Company, 1888.

[3] Bernheim, H. *Suggestive therapeutics*. New York, London Book Company, 1947. [First French ed., 1886.]

phenomena of hypnosis but felt that this did not exclude the fact of physical influences likewise bringing them about. This, in brief, is the substance of the Nancy-Salpêtrière controversy.

When we arrive at the data pertaining to the School de la Charité, it seems best to quote directly De Courmelles' opening paragraph of the chapter devoted to this group:

> The school of the Hospital de la Charité acts as a kind of connecting link between that of Nancy and the Salpêtrière, accepting as it does both methods and theories. Dr. J. Luys, member of the Academy of Medicine, has performed many curious experiments in this hospital. Both professor and experiments have, however, shared the usual fate of investigators and new ideas, and have been viewed with great suspicion. Emotions produced by physical agents, and the action of medicines not immediately applied, are by no means facts recognized by the scientific world. After examining the different phases of hypnotic sleep, we will relate all the facts as they come under our notice.

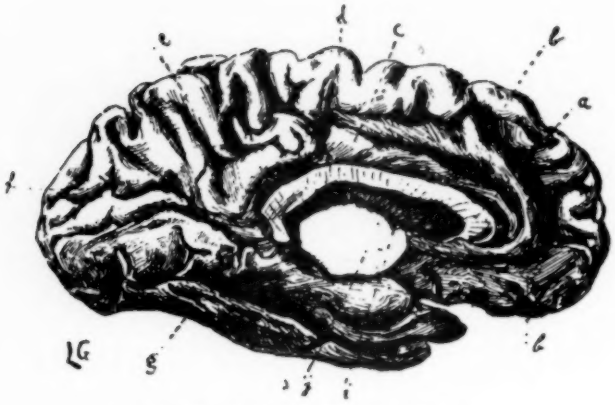
Accustomed as most people are at present to think of hypnotic phenomena in terms of their psychological implications, the reader of De Courmelles' volume can become easily confused about exactly what he was trying to say, and for this reason it is essential to deal directly with his definition of terms. In a way this may appear to add to the confusion, but perhaps it will assist in understanding just what the School de la Charité stood for. In his chapter on the Salpêtrière, De Courmelles wrote, when dealing with hypnotism and magnetism and the distinction between them:

> This distinction is not generally made, hence the confusion between the two methods. Whenever the word *hypnotism* is therefore employed, the reader must remember that it is sleep *induced* by physical agents that is understood, that is to say sleep obtained by fixing the gaze on some object (as Braid discovered) or by some sudden sound, like that of a Chinese gong (such as is used at the Salpêtrière). When, on the other hand, the word *magnetism* is employed, it will be understood that reference is made to a subject passing from a waking condition into that of sleep, owing to the personal action of the experimentalist on the experimentized. This latter explanation is not yet scientifically accepted as an absolute fact, but it will be shown, by the valuable facts and opinions set out in this work, that it must be taken into due consideration, independently of the undeniable influence exercised by the imagination and the frequent and unavoidable intermingling of hypnotic and magnetic actions.

Regarding magnetism, it would seem that the question of scientific acceptance at that time did not affect his own decision, because in the conclusion of De Courmelles' book, where, incidentally, he dealt mostly with the problem of free will, he wrote, "Doubt is impossible: *hypnotism does exist, and magnetism is equally un-*

Dr. Luys

DR. LUYS' LECTURE AT THE CHARITE.



Brain of an hypnotisable neuropathe.*

deniable." It would appear, then, that in this volume at least, the methods and theories of the school he represented as spokesman for the Charité group went further than just to serve as a connecting link between the Nancy and Salpêtrière Schools. It encompassed the physicalist doctrine of Salpêtrière, the suggestionist orientation of Nancy, and the fluidist concepts of Mesmer and his followers. It is somewhat difficult to decide exactly what De Courmelles felt about the philosophical background of Mesmer's universal fluid concept although reference is made to this. While he encompassed this threefold area, the impression is not readily obtained, however, that any real attempt was made at integration.

Consistent with De Courmelles' threefold approach to this entire problem is the fact that he pointed out that Braid "did not seek to deny magnetism" and he quoted from Braid's *Neurypnology*[4] to show that this investigator was giving consideration to "*hypnotism and mesmerism as two distinct agents.*" Furthermore, similar doubts on the part of the Nancy group, even of Liébeault himself, are specifically alluded to. All of this is mentioned now to assist in the clarification of the beliefs and theories of De Courmelles and the Charité School which he records as his own affiliation.

In recounting these activities, De Courmelles, in addition to the few references to his own work, deals largely with Luys and virtually not at all with the others he had mentioned as representatives of this school. For this reason and because Luys was considered the leader of this group, a number of comments about him will be presented.

It seems desirable to start with a quotation from one of the lectures given by Luys at the Charité in June, 1888. "The hypnotizer is nothing; the hypnotized subject is everything." Recognition of the importance of the rôle of the subject rather than that of the hypnotist was far more widespread at the close of the century among the investigators at that time than persons working today in psychological areas give them credit for. As will become evident, this point of view is sufficiently in keeping with "physicalist" concepts as not to be too surprising.

Shortly after writing in his chapter on the Charité that "the action of physical agents—even at a distance—and of suggestion are both admitted at la Charité," De Courmelles commented further:

4 Braid, J. *Neurypnology; or, the rationale of nervous sleep, considered in relation with animal magnetism.* London, John Churchill, 1843.

> We are surrounded in nature by a subtle fluid that scientific men call ether, and which is supposed to be imponderable; it would seem possible that this ambient medium—the nature of its substance being unknown—may transmit the perturbations of nerve power. This is the conclusion that Dr. Luys' theories point to, and in this it is similar to those of magnetizers. The brain nerve cells vibrate under the influence of different causes, why should it be thought that the movement does not extend further than the cranium?

Since Luys' name is invariably linked with his revolving mirror, an account of this is offered.

> The hypnotic state, generally produced by the contemplation of a bright spot, a lamp, or the human eye, is in his method induced by a peculiar kind of mirror. The mirrors are made of pieces of wood cut prismatically in which fragments of mirrors are incrusted; they are generally double, and placed crosswise, and by means of clockwork revolve automatically. They are the same as sportsmen use to attract larks, the rays of the sun being caught and reflected on every side and from all points of the horizon. If the little mirrors in each branch are placed in parallel lines in front of a patient, and the rotation is rapid, the optic organ soon becomes fatigued, and a calming, soothing somnolence ensues. At first it is not a deep sleep, the eye-lids are scarcely heavy, the drowsiness slight and restorative. By degrees, by a species of training, the hypnotic sleep differs more and more from natural sleep, the individual abandons himself more and more completely, and falls into one of the regular phases of hypnotic sleep. Without a word, without a suggestion or any other action, Dr. Luys has made wonderful cures. Wecker, the oculist, has by the same means entirely cured spasms of the eye-lids. Javal, an ophthalmologist, member of the Academy of Medicine, and myself are engaged in researches in the same direction.

Aside from the induction procedure identified with Luys, De Courmelles described the experiments dealing with emotions produced through motor attitudes adopted in hypnosis. Studies of the consistency of the apparent emotional attitudes following the assumption of various bodily positions and appearances as would obtain in fear, joy, anger, and so on, received considerable attention not only among the Charité group, but with the Salpêtrière School, judging by the Binet-Féré volume.

Luys was interested in investigating the emotional reactions of hypnotic subjects which were consistent with the contents of sealed tubes placed on the necks of these subjects, the latter being unaware of the ingredients involved. Thus, among the results, ". . . alcohol produces merry or furious drunkenness, according as it is distilled from corn or from wine; water produces hydrophobia; ipecac, vomiting. . . ." De Courmelles mentioned that in June, 1887, Jules Voisin, a physician at the Salpêtrière, told of having repeated such procedures by calling out the names of the supposed contents while using empty tubes and of getting results

previously obtained with appropriately filled tubes, and later of having run through the series again with empty tubes and without verbalization, only to find that the same responses consistent with good recall were elicited from the subjects. The experimental data and results appear to have been presented by De Courmelles side by side with the arguments of "physical" and "suggestive" effects which had to be taken into consideration. The extent to which he took measures to resolve the problem of differences of opinion is not quite clear. He did mention that this work at the Charité followed the experiments along these lines by Burot and Bourru of the School of Medicine at Rochefort. After being "recognized as facts" at the Charité, the results were investigated by a special commission of the Academy of Medicine and were rejected.

Luys also induced emotions with blue, yellow, red, and green hollow glass balls, and it was claimed that blue produced terror and horror, whereas yellow produced joy and mirth. Similar effects were produced with magnets, joy and mirth being obtained, it was claimed, with the north pole and repulsion with the south pole. A magnetic pole applied to each hand produced "experimental indifference." The transfer of diseases from one subject to another by the action of magnets was also employed, and De Courmelles said that Babinski conceived of this idea in 1886.

In keeping with the anatomical and structural pathological interests during the course of these investigations, Luys and Bacchi were said to have discovered a hyperemia of the retina in hypnotized subjects. De Courmelles remarked further that additional experiments should determine whether this phenomenon could be produced voluntarily (the topic was discussed in a chapter on simulation) but beyond this he offered nothing more at the time.

The School de la Charité appears rather definitely to have been therapeutically oriented. Luys was quoted as having said, "I consider that it is important to popularize one element in the new resources that the practice of hypnotism offers, in its therapeutic treatment of nervous diseases." Following this an account is rendered in the words of Luys of the treatment of a patient with hysterical paraplegia followed by relief of symptoms of more than three years' duration at the time the book was being written. Now this case possesses added interest because it involved the induction of a temporary personality change in the patient with the assumption of the personality of another patient with no motor disability and with a "vivacious" disposition.

De Courmelles dealt at length with hypnosis and antisocial behavior and it seems that on this score he differed with Luys who accepted the view that hypnosis could lend itself to the production of criminal acts. A section of Luys' *Clinical Lectures on Hypnotism* is quoted directly. The entire topic is extremely complicated, and no further comment will be made here.

Regarding the question of susceptibility to hypnotic procedure and production of phenomena, De Courmelles wrote: "The School of Nancy entirely agrees with—and even goes farther than—the ideas of its founder, and only admits of suggestion—or the action of imagination—as the sole hypnotic agent. Notwithstanding this opinion, we must recognize, with the Salpêtrière School, that it only has any action on *nervous* subjects."

Hypnotic anaesthesia for surgical procedures was of interest to several investigators in the Paris hospitals at that time, and De Courmelles described the excision of a hypodermic needle tip from the arm of a patient at the Charité. The surgeon was Dr. Segond; De Courmelles was one of the observers. The actual extent of surgical procedures under hypnosis as performed at the Charité cannot be ascertained from his account although he did mention having himself performed some minor surgery with the use of hypnosis.

This volume on hypnotism contains many illustrations which are of interest in the history of the subject. Limiting comment to the Charité School only, three may be mentioned. There is a picture of Luys, which furnishes some impression of the appearance of the leader of this group. Then, giving some idea of the clinical demonstrations of that time, there is "Dr. Luys' Lecture at the Charité." Luys, a female hypnotic subject, and a group of students are portrayed here. Finally, and what may prove to be of special interest, is an illustration of a "Brain of an hypnotisable neuropathe." A footnote reads: "This brain is the first and only one that has as yet been submitted to examination"—a true record of basic neuroanatomical orientation.

In summary, the School of the Hospital de la Charité, according to De Courmelles as a representative of this group, functioned within a three-fold orientation: hypnotism, magnetism, and suggestion. The experimental and physicalist approach parallelled the Salpêtrière School. The therapeutic and suggestion concepts were in keeping with the Nancy School. The total impression was one of leaning more toward the Charcot faction at Salpêtrière.

Post-Mesmeric fluidist concepts appear to have been retained. The chief investigator of the Charité School was Luys whose name remains with us today, although he never matched the stature of Charcot as a neurologist nor of Liébeault or Bernheim as hypnotists. His revolving mirror is still remembered. His studies on motor attitudes and emotion in hypnosis have just about been forgotten, although there seems to be a recurrence of interest now in a somewhat similar series of studies without historical reference to Luys' original work. His experiments with the induction of hypnotic behavior as reactions appropriate to the ingredients of sealed tubes introduced in the vicinity of the subjects have been essentially dismissed. Other associates of the Charité School are listed by De Courmelles as Bottey, L. R. Regnier, and de Grandchamps in addition to Luys and himself. Bottey is mentioned fairly often in other works on hypnosis, the remaining two less frequently. Perhaps it is to be assumed that all of this group, and others who have not been referred to, agreed essentially with the opinions expressed by De Courmelles unless indicated otherwise, but this has yet to be evaluated. Whether the Charité School was recognized during its existence as distinct a group as De Courmelles seems to imply is not quite clear, and further study should clarify this too. Finally, it may be of interest to gather more information about De Courmelles himself.

Ernest H. Starling

His Contribution to Medicine

RALPH COLP, JR.*

FEW have contributed more to the scientific background of modern medicine than the Englishman, Ernest Henry Starling.[1] The story of Starling begins in 1882 when at the age of sixteen he matriculated at the University of London to study medicine at Guy's Hospital, choosing this because his uncle had had his training there. At that time his ambition was to become a physician and practise in Harley Street. From the very beginning, when he took the matriculation examination, he was outstanding as a student; and in medical school he continued to excel, winning so many prizes that, as his old friend C. J. Martin remarked, "If he had liquidated the many gold medals awarded to him he would have been able to enjoy comparative affluence." When he came to the study of physiology in his second year, his course was set. The great textbook of Sir Michael Foster certainly influenced him, but in going over his notebooks kept when he was seventeen one feels that physiology was largely his own discovery; in them "one recognizes phrases and points of view characteristic of him in later life." He read many original articles in German and French and all the back numbers of the English *Journal of Physiology*. By twenty he had determined to become a physiologist if such a career were possible. In the vacation between the second and third medical school terms he managed to go abroad to Germany, then the center of medical research, and worked for a few months in the laboratory of Kühne, a pioneer in the physiology of digestion who has been credited with the introduction of such words as "trypsin" and "enzyme." From there he returned, "with his hair *en brosse*, much teutonised, and more than ever determined to become a physiologist."

However, he put these aspirations aside for two years while

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[1] No full-scale biography of Starling exists. The two best short biographies are: (i) Martin, C. J. Ernest Henry Starling: life and work. *Brit. med. J.*, 1927, *1*, 900-904; (ii) Evans, C. Lovatt. Ernest Henry Starling: 1866-1927. In: *British masters of medicine*, ed. by Sir D'Arcy Power. London, 1936, 221-235. Shorter biographical notes have been written by Sir William Hale-White (*Guy's Hosp. Gaz.*, 1927, *41*, 222-224) and by Lovatt Evans (*Heart*, 1927-29, *14*, 107-110; *Biochem. J.*, 1928, 22, 618-620).

he completed his medical studies. Then, at the age of twenty-three he abandoned what would have undoubtedly been a brilliant career in the practice of medicine and became a demonstrator in physiology at Guy's Hospital, thus embarking on a full-time career as an investigator. Full-time positions in research were rare then in England, and so slender were the rewards of Starling's post that had it not been for a grant from the British Medical Association, he would have had to abandon his ambition at the outset. For a medical man to devote his life entirely to scientific investigation was new in England. The great physicians of Guy's Hospital who had obtained immortality through having their names attached to a disease—Bright, Parkinson, Addison, and Hodgkin—had regarded investigation as their hobby rather than as their life work. Starling represented a new generation of English doctors which was to include J. S. Haldane, Sherrington, Barcroft, and F. G. Hopkins (the last a classmate of Starling at Guy's) who, as Starling said, "were inspired with enthusiasm to devote their lives to scientific research," and were destined to form the great school of physiology of their time.[2]

In becoming a full-time investigator, Starling categorically rejected his ambition of six years earlier for a Harley Street practice. He said: "Under present conditions a man when he obtains a position on a hospital staff . . . engages his consulting rooms at a high rental in some fashionable quarter. He imagines it is more to his advantage to work for the crumbs which fall from the great man's table than to spend his time in adding to our knowledge of medicine. . . . In the course of years the man has wasted the productive years of his life; has lost touch with the exact methods of the laboratory; has been left behind by the advance of the collateral biological sciences. He may now become a respected West-end consultant; he will never add anything to the science of medicine."

From the outset, Starling felt that only through physiological investigation could one understand disease and thus "add" to the "science of medicine."[3] Sir Charles Sherrington, who knew him when he was first teaching at Guy's, observed that "medicine was

[2] Starling's *A century of physiology* (London, 1927) gives a succinct survey of the history of physiology particularly for the past one hundred years in France, Germany, and England. "London's debt to medicine" (*Brit. med. J.*, 1903, 2, 911-913) contains Starling's criticism of existing British medicine.

[3] "The wisdom of the body" (Lancet, 1923, 2, 865-870) contains Starling's ideas on the relation between scientific research and medical progress in their most mature form. His *Elements of human physiology* (London, 1892) gives his views on this subject when he was just entering physiology.

certainly his source of inspiration then, and I think it always remained so." And Starling's chief at Guy's, Sir William Hale-White, has written: "His interest in medicine remained throughout his life, for he would always discuss with enthusiasm how his physiological work helped the elucidation of medical problems." A desire to cure the sick, and he respected medicine as possessing this power (he referred to medicine as the "aristocrat of professions"), was one of the central motives of his life, and he never wavered from it. Towards the close of his life he wrote: "Only by following out the injunction of our great predecessor [William Harvey] to search out and study the secrets of nature by way of experiment can we hope to attain to a comprehension of the 'wisdom of the body and understanding of the heart,' and thereby to the mastery of disease and pain which will enable us to relieve the burden of mankind." In these words—the theme of all his public talks—he summed up the idea of medical progress through scientific investigation and at the same time pointed to his own achievements extending over a period of thirty-five years as an example.

During the thirty-five years between 1892 and 1927, because of the progress in the biological sciences, medicine was making the greatest advance in its history. Starling's biography is part of this advance; his life was a great 'success story,' combining an ideal and its realization. He began active physiological investigation in 1891; physiology then represented one of the most active of the biological sciences, with great schools flourishing in Germany, to a lesser extent in France, but not as yet in England. The growth of chemistry and physics during the earlier part of the nineteenth century, particularly the enunciation of the two laws of the conservation of matter and energy, had, as Starling said, "made it possible for the first time to investigate the processes occurring in the living body with some hope of discovering their ultimate laws and character." The problem next confronting physiological workers was to devise methods for utilizing these new chemical and physical techniques to measure physiological phenomena which up till then had only been described.[4]

With William Bayliss, his brother-in-law and life-long collaborator, Starling first began work on devising new methods to measure the electrical current, nervous innervation, and pressure changes

[4] Starling's concepts of the problems in physiology when he entered it are contained in *A century of physiology* (London, 1927).

in the heart.[5] His first foretaste of fame came in 1892 when he started investigating lymph formation. At that time he was an unknown youth of twenty-six. By 1897, when he was thirty-one, he had revolutionized our concepts in this field and had become a leader in physiology.[6]

The problem of lymph formation was one of fluids; could it be explained by fluid forces? Here were two bodies of fluid—blood and lymph—separated by a wall of endothelial cells, the blood capillaries. The distribution of fluid on either side might be explained by the three known fluid forces: diffusion, osmosis, and filtration. If this could not be demonstrated, one must postulate that the endothelial cells themselves intervened and performed some type of so-called "vital" activity. All ideas on this subject dated back to 1850 when the German physiologist Carl Ludwig, utilizing a mercurial manometer, explained that lymph formation is directly dependent upon the blood pressure in the capillaries and thus essentially a process of filtration and diffusion. The investigation of this so-called "mechanical theory" of Ludwig became the subject of all subsequent research. In 1891, Rudolf Heidenhain of Breslau observed that in obstruction of the thoracic aorta and inferior vena cava, though there is a fall of body blood pressure, the lymph flow from the thoracic duct is not decreased, sometimes is even increased, and that when substances such as peptone and sugar are injected into the blood stream, there is an increased flow of a more concentrated lymph. In such situations lymph flow does not depend on the blood pressure and must be due to the "vital" activity of the cells. This work of Heidenhain produced a profound impression, for it challenged the traditional concepts of lymph formation.

Starling journeyed to Breslau and, working under Heidenhain, confirmed many of his findings. In his first published paper he agreed with him as to the "vital" activity of the endothelial cells.

[5] The early work of Starling and Bayliss on the heart is to be found in "Report on the electromotive phenomena of the mammalian heart" (*Brit. med. J.*, 1891, *2*, 186-187); "On some points in the innervation of the mammalian heart" (*J. Physiol.*, 1892, *13*, 407-418); and "On the form of the intraventricular and aortic pressure curves obtained by a new method" (*Int. Mschr. Anat. Physiol.*, 1893, *11*, 426-435).

[6] Starling's "The production and absorption of lymph" (in *A text-book of physiology*, ed. by E. A. Schafer, London, 1899, *1*, 265-312) gives an excellent, comprehensive, overall account of the work on lymph. His *The fluids of the body* (Chicago, 1909) is prolix and lacks much analytical power. More detailed accounts are contained in his articles in *J. Physiol.*: 1893, *14*, 131-153; 1894, *16*, 140-155 and 224-267; 1894-95, *17*, 30-47; 1895, *18*, 106-116; 1895-96, *19*, 312-326. The last contains his original account of his discovery of the osmotic pressure of proteins.

Back in England he repeated Heidenhain's work on the effect of obstructing the aorta and inferior vena cava; despite a fall of body blood pressure, in each of these conditions there was a somewhat increased lymph flow from the thoracic duct. Starling asked: Where, from what part of the body did this increased lymph come? For over six months he struggled with this problem to which there seemed to be no solution. In his own words he was "almost in despair"; but then he suddenly discovered that in both of these conditions there is an increased lymph flow from the liver and he was able to demonstrate a direct relationship between intracapillary liver pressure and lymph production. The puzzle proceeded to unravel, and he next dealt with Heidenhain's other observations and showed that rather than denying the "mechanical theory," they furnished a powerful proof for it. The increased concentrated lymph following peptone injection resulted from enhanced permeability of the capillary due to injury of its wall, while the lymph flow following glucose injection depended on an increased capillary filtration pressure because the glucose pulled fluid from the tissues into the blood vessels. This work took three years, and from it emerged the concept that lymph production results from (i) intracapillary pressure, and (ii) permeability of the capillary wall. Since then these factors have not been seriously challenged. Starling throughout his life believed in the cumulative and progressive scientific tradition. He said: ". . . I think I ought to emphasize that my experiments are merely a continuation and not a refutation of those of Heidenhain. . . . To [his] work and teaching I am indebted for all the results I have succeeded in obtaining." Starling liked to feel that he was an integral part of a great force, past and present.

Having dealt with the exit of fluid from the blood vessels, Starling now attacked the problem of their fluid uptake. Again, the task was to fit known fluid forces into a biological situation. For fifty years it had been a point of hot debate as to whether blood capillaries could take up fluid at all. In a conclusive experiment Starling proved that they could. What was the mechanism? A number of possibilities were suggested, tested, but disregarded. Then, in 1896, Starling found the answer in the osmotic pressure of the serum proteins. Here was a force which, though known, had been disregarded. He constructed an osmometer and measured the osmotic pressure of blood proteins (he was the first to do this) and

then showed that this pressure from within the blood capillaries accounted for the movement of fluid into the blood vessel.

The picture of the factors controlling fluid movement back and forth across a capillary wall stands as the framework of the concept we have today. It is briefly this. In every capillary there is hydrostatic ejection of fluid in the proximal portion, while in the distal portion, where the hydrostatic pressure gradient has declined, there is return of an equivalent volume of fluid under the influence of the osmotic pressure of the plasma proteins. The volume of oscillating filtrate is possibly of the order of hundreds of litres daily. The fact that the blood volume remains constant is evidence of the accurate balance struck between hydrostatic pressure and serum protein osmotic pressure. Were it not for the latter, a man would lose the whole of his serum into his tissue spaces within ten seconds. The back-and-forth movement of fluid between the capillaries and tissues facilitates exchange of substances so that the fluid bathing the body tissues is maintained constant in all its properties.

Now, with Bayliss, Starling turned to a new problem, the physiology of the intestine.[7] This was a frontier field which had only recently been opened up, mainly due to the work of the Russian physiologist, Pavlov. Speaking of the problems to be encountered Starling had said: ". . . We shall have to deal in turn with the mechanisms of the secretion of the digestive juices, the changes wrought by them on the foodstuffs, and the movements of the alimentary canal whereby all parts of the food are brought into intimate admixture with the juices . . ." Pavlov, having perfected a technique of fistula formation, had been able to give a picture of secretion and digestion. Starling's imagination was fired by what he called the "analytical method" of Pavlov, and he and Bayliss began a study of the movements of the intestine, attacking the problem by their own analytical method.[8] The invention of a smoke-blackened kymographic drum for recognizing movements anywhere in the body had been a milestone, and its sensitive surface had been used to record the slightest movement of any body

[7] Two excellent comprehensive accounts by Starling of his and Bayliss' work on the physiology of digestion are *"Mercer's Company lectures on recent advances in the physiology of digestion* (Chicago, 1906) and "The physiology of digestion, gastric and intestinal" (*Guy's Hosp. Rep.*, 1910, *64*, 141-295).

[8] A detailed account, by Starling and Bayliss, of the movements of the intestine is "The movement and innervation of the small intestine" (*J. Physiol.*, 1899, *24*, 99-143).

organ. Starling and Bayliss invented many new kymographic drum-recording instruments, and after eighteen months' work they were able to capture the essential movements of the gut in a few kymographic records. They summarized this as follows: (i) The ordinary movements of the gut, peristaltic contractions, are co-ordinate reflexes carried out by a local nervous mechanism; (ii) stimulation of the gut produces contraction above, dilatation below (the "Law of the Intestine"), explaining how food is moved from mouth to anus; besides the local mechanism, every part of the gut is under the control of the autonomic nervous system, the splanchnic nerves which are inhibitory, and the vagi which are both inhibitory and excitatory. Shortly after this disclosure the American physiologist, Walter B. Cannon, further investigated the problem, using barium and X-rays.

Bayliss and Starling took up the mechanism of pancreatic secretion: what induced the pancreas to secrete its juice?[9] The answer to this query was their most famous discovery. Pavlov had shown that gastric secretion was under the influence of the central nervous system, and it was assumed that some such nervous pattern must apply to the pancreas. Where was the nervous path of pancreatic secretion? It was known that after exclusion of all nerves except those in the pancreas itself, pancreatic juice was obtained by the introduction of acid into the duodenum; evidently there was some intrinsic local nervous mechanism in the pancreas. To track this down became the task of workers from St. Petersburg to London. Bayliss and Starling entered the field also believing that they were dealing "with an extension of the local reflexes whose action on the movements of the intestine we have already investigated." What they found caused, according to Boris Babkin who at that time was working in Pavlov's laboratory, a "sensation." They repeated the work of previous observers. Then they went a step further and performed what Starling called an "obvious control experiment." They injected acid into the small intestine after all of its nervous connections had been severed. C. J. Martin has told us the rest:

I happened to be present at their discovery (January 16, 1902). In an anesthetized dog a loop of jejunum was tied at both ends and the nerves

[9] Starling and Bayliss' description of the discovery and properties of secretin is in "The mechanism of pancreatic secretion" (*J. Physiol.*, 1902, *28*, 325-353). "Discovery and research" (*Nature*, 1924, *113*, 606-607), contains Starling's views on the discovery of secretin twenty years later. Interesting comments on the discovery of secretin are made in Boris Babkin's *Pavlov: a biography* (Chicago, 1949, p. 228) and *The secretory mechanism of the digestive glands* (New York, 1944, p. 493).

supplying it dissected out so that it was connected with the rest of the body only by its blood vessels. On the introduction of some weak HCL into the duodenum, secretion from the pancreas occurred and continued for some minutes. After this had subsided a few cubic centimeters of acid were introduced into the loop of intestine. To our surprise a similar marked secretion was produced. I remember Starling saying 'then it must be a chemical reflex.' Rapidly cutting off a further piece of jejunum he rubbed its mucous membrane with sand in some weak HCL, filtered it and injected it into the jugular vein of the animal. After a few minutes the pancreas responded by a much greater secretion than had occurred before.

And he concludes, "It was a great afternoon." Thus secretin, hitherto unknown and unimagined, entered the world and with it the concept that, in addition to a nervous reflex, a humoral reflex can cause intestinal secretion.

It is always interesting to ask what, barring chance, are the attributes which make for a great discovery? Twenty years later Starling, commenting on his discovery of secretin, tended to decry it: ". . . there were at that time half a dozen workers skating along the edge of the discovery, and it is difficult to comprehend why . . . [one] for example did not take the one further step which would have made them and not us the discoverers of secretin." Why? All the rest were prejudiced by the purely nervous phenomena; it was his ability to think of a new mechanism that gave Starling the laurels. Boris Babkin who had spent his life studying secretion said: "It required a new conception, unprejudiced by protracted research in the field and, I would add, a bold method of attack to make possible a satisfactory solution." These Starling possessed and others did not.

Secretin was and still is one of the best examples of the group of internal secretions. Starling recognized this. It was a period when, influenced by the great generalization of evolution, physiology was tending toward laws and theories, and away from isolated facts.[10] Most of the internal secretions were then known, but as Starling later explained: "It was not till the discovery of secretin by Bayliss and myself in 1902 that we recognized that these so-called internal secretions were merely isolated examples of a great system of correlation of the activities, chemical and otherwise, of different organs, not by the central nervous system but by the intermediation of the blood, by the discharge into the blood stream of

[10] The Croonian Lectures, "The chemical correlation of the functions of the body" (*Lancet*, 1905, 2, 339-341, 423-425, 501-503, and 579-583; also *Proc. roy. soc.*, 1904, 67, 310-322) contain the theory of hormones as Starling propounded it. Bayliss, *Principles of general physiology* (London, 1918, 708-709) gives further information on the history and meaning of the word hormone.

drug-like substances in minute proportions which evoked an appropriate reaction in distant parts of the body." At the suggestion of a fellow worker Hardy, Starling and Bayliss adopted the ancient Greek word hormone, meaning to excite, as a name for this class of internal secretions. In his Croonian Lectures of 1904 and 1905 Starling presented an exciting and dynamic picture of a hitherto unrealized pattern of body regulators, he summarized the available knowledge, showed how hormones evolved with the evolution of man, and at the same time anchored this picture to chemistry by classifying hormones according to Paul Ehrlich's classification of drugs. And Starling the physician, called by one of his friends "by no means unromantic," saw in hormones the fulfillment of the perennial medical ideal of curing the sick. "I hope to be able to vindicate to you the assumption which is the basis of medical practice; . . ." these were the words with which he began his Croonian Lecture to the Royal College of Physicians in 1905. This theory of hormones, Sherrington's integrative action of the nervous system, and F. G. Hopkins' ideas on vitamins, all set forth around 1905, are some of the few physiological theories which have survived as a basis for clinical medicine.

Starling's achievements were recognized and he was accorded many honors and positions, including the coveted Jodrell Professorship of Physiology at University College, London. By thirty-three, with nearly one-half of his life ahead of him, he found himself a public figure of influence and weight. The position of a famous man now gave full scope to a powerful personality. As Lovatt Evans, his pupil and editor of his well-known text, *Principles of Human Physiology,* put it: "Starling was destined by his outstanding and thrilling personality to dominate and lead, and he was endowed with tremendous energy. . . ." Not the least important of his activities for medicine were those outside of the laboratory. It was good to be a scientist in the nineteenth century —there was an atmosphere of unbounded optimism, social evils were recognized, but it was felt that the tremendous growth of science would in the end automatically obliterate them. Ideologically, Starling was a nineteenth century scientist and as a public figure he played the twin rôle of agitator and prophet.[11] He said, and this summarized his views, "In our childhood most of us learned that suffering and death came into the world through sin.

[11] Starling's philosophy of science is best stated in the "Wisdom of the body" from which this quotation is drawn.

Now, when as physicians, we stand on the other side of good and evil, we know that the sin for which man is continually paying the penalty is not necessarily failure to comply with some one or other of the rough tribal adjustments to the environment which we call morality, but is always and in every case ignorance or disregard of the immutable workings of the forces of nature, which is continually revealed to us by scientific investigation."

As a young man he had been responsible for completely equipping Guy's Hospital with new laboratories, and in his more mature years he achieved the construction of a vast medical center in London with University College as its nucleus.[12] What Starling visualized (and he was influenced by his observations in Germany) has largely come into being in England and in the United States today. In brief, it was a medical center, comprising a university and hospital (the association of which was the crux of the plan) with laboratories and clinics working in close conjunction, all focused on the scientific investigation of disease, staffed by full-time men (who, however, would not be prevented from engaging in private practice). Starling developed this in numerous speeches, but the practical chances for such a scheme were slight as University College at that time was in financial straits. But it was an age when private philanthropy, especially in the United States, was financing medical projects. For four years Starling did not enter the laboratory but devoted himself entirely to this undertaking of which he was the driving force. Funds were raised by private subscription, and in 1909 a part of the plan was realized when the Physiological Institute at University College was opened. In 1923 the Rockefeller Foundation granted the remainder of the necessary funds, and Starling had the satisfaction of seeing his twenty-year-old plan put into effect. Today the center at University College stands as one of the great medical centers in the world.

In the field of general science education he was an unsparing critic of the English educational system which he dubbed "feudal" because those who directed the government of England were ignorant of the rudiments of science.[13] In medical education he came out for correlation of clinical and preclinical subjects; he stressed that medical educators must be constantly alert and "ready

[12] Details of the building at Guy's and University College are given in the two biographies by Martin and Evans. Starling's program for the Medical Center at University College is outlined in "London's debt to medicine."

[13] "Natural science in education" (*Lancet*, 1918, 2, 365-368) contains Starling's ideas on a general science education.

continually to adjust their methods of teaching in accordance with the changing aspect of their subject."[14]

As a representative of science, serving society, Starling came into his own during World War I when he was an adviser to the English government on nutrition.[15] The English wartime Prime Minister, David Lloyd George, subsequently said: "The food question ultimately decided the issue of this war." Because of the German blockade England found itself faced by the specter of famine, and the government was forced to institute a vast program of food production, control, and distribution. During the preceding fifty years nutrition had advanced to the stage where it was possible to formulate an adequate diet for man, and Starling took part in one of the first applications of a body of physiological knowledge to the needs of a whole population. At the time he wrote: ". . . science . . . as the ordered summary of the whole of human experience presents the needs for solving any and every problem with which we may be faced." His work on nutrition was an example of this. He mastered the available knowledge on nutrition and then translated this knowledge into everyday demands, formulating a program for feeding the English nation that turned out to be a great success. As two specific war measures he advocated that (i) animal lands be converted to grow grains and vegetables, and that if necessary cattle be sacrified, and (ii) he insisted that bread be left unrationed to prevent what he called "industrial violence." Agitation against the bread ration had been the starting point for the revolutions in Russia and Germany. At that time these measures were controversial, but it is interesting that both were part of the highly developed food policy of England during World War II.

To return to Starling's research activities. In 1909 with the opening of the Institute of Physiology at University College he began research on the heart in a new laboratory. For the heart he felt an admiration verging on sentiment; he referred to it as an organ which possessed "intelligent prescience." Since his medical student

[14] Starling's ideas on medical education are set forth in "A discussion of the scientific education of the medical student" (*Brit. med. J.*, 1908, 2, 374-376). This is a discussion by scientists such as Starling, Sherrington, Armstrong, and Sims Woodhead and clinicians such as Osler and Sir Felix Semon.

[15] A general survey of the food problems of England during World War I is contained in David Lloyd George's "Controlling the food supplies" (*War Memoirs*, Boston 1934, 3, 199-267). Starling's own ideas on nutrition are fully set forth in *The Oliver Sharpey Lectures on the feeding of nations, a study in applied physiology* (London, 1919).

days he had been interested in the mechanism of the heart's adaptation to the great demands—normal and pathological—which were placed upon it. His earliest interest in the organ centered on the vascular dynamics of heart failure. Heart failure is one of the most common diseases; to comprehend the changes in blood volume and their cause has been one of the main foci of medical research in this field. In 1897 Starling challenged the concepts of the German pathologist, Julius Cohnheim, which were then generally accepted, and demonstrated that in heart failure the elevation of the peripheral venous pressure could not be due to the mechanical backward failure of the heart. He then postulated that this elevated venous pressure must be due to an increased blood volume, which in turn could probably be ascribed to retention of fluid by the kidney. The subsequent discovery that in heart failure there is an increased blood volume, and retention of salt and water by the kidney has been one of the important advances in modern medicine, and research in this field is continuing today.[16]

Starling's new work in 1909 began with a study of the effects of carbon dioxide on the heart; this led to the use of the heart-lung preparation, and he worked on this apparatus for the rest of his life.[17] The heart-lung preparation is a fascinating and ingenious apparatus with manifold ramifications. In brief, an animal's heart and lungs are cut out from its body, the entire lesser pulmonary circulation remaining intact, and this is kept alive and functioning from eight to twelve hours. It is like separating an automatic self-running part from a large machine of many parts. The heart-lung preparation had been used by Pavlov, and Newell Martin at Johns Hopkins, but Starling added an innovation to it which enabled him to tell a great story. He devised an artificial resistance which successfully imitated the peripheral arteriolar resistance of the body. While all other conditions were kept constant he was able to measure the separate effects of variations of rate, venous flow and arterial resistance on the cardiac output. In other words, he could now study the mechanism of the adaptation of the heart.

William Harvey, the discoverer of the circulation of the blood,

16 "The effects of heart failure on the circulation" (*Lancet*, 1897, *1*, 652-655) is Starling's demonstration that back pressure alone cannot elevate venous pressure in heart failure.

17 Starling's *The Linacre Lecture on the law of the heart* (London, 1918) gives a general survey of the work on the heart-lung preparation. Two excellent short surveys by Starling are "Some heart problems" (*Lancet*, 1921, *2*, 1199-1202) and "The law of the heart" (*Lancet*, 1921, *2*, 212-213). A detailed account of the discovery of the "law of the heart" by Starling is "The regulation of the heart beat" (*J. Physiol.*, 1914, *48*, 465-513).

whom Starling frequently referred to and in whose tradition he pictured himself, had demonstrated three hundred years earlier that the heart was not a 'fount of fire' but a hydraulic apparatus. Starling proceeded by asking how this hydraulic apparatus worked so that at one time it put out about four liters and at another time thirty-two liters, and each time adjusted its output to the demands of the body. The heart-lung preparation enabled him to give the answer. From the beginning there was the thrill of a new problem. He wrote: "To search out the intimate character of this power of adaptation is a problem almost as enthralling in interest as the demonstration of the circulation itself."

With the heart-lung preparation Starling developed what he called a "synthetic method" of studying body processes. As he described it, an organ is first isolated and kept alive, and its reactions to various stimuli recorded; then the various influences—chemical and nervous to which it is exposed in the body—are reconstructed and from this a picture of the totality of its reactions in the intact body built up. In this manner he proceeded to depict the heart's activities. A select band of workers from all over the world had come to University College, now a center for heart research, and Starling was the motivating force. Using the heart-lung preparation, the most varied aspects of the heart were investigated—heart muscle metabolism, coronary circulation, the action of carbon dioxide and other drugs on the heart, and the metabolism of the diabetic heart (here by the narrowest of margins Starling missed discovering insulin). There gradually emerged the story of how the heart adapts itself: within limits, greater than ever supposed, the heart output was shown to be independent of peripheral resistance and increase in rate, but to vary directly with increased venous inflow. The isolated heart stripped of all nerve control was a marvelous automatic machine perfectly regulated to respond to the fast changing needs of the body. What was the intrinsic property in this isolated heart—cardiac muscle—which enabled it to perform so well? This Starling was able to answer. By inserting instruments which measured heart muscle volume and intracardiac pressure he showed that the heart muscle first dilated (because of the force of the retained blood) and thus was able to produce more energy for contraction. This is known as Starling's "Law of the Heart." It fitted in perfectly with the best contemporary work on muscle contraction, that of the Swedish physiologist, Blix, and the English physiologist, A. V. Hill, who had shown in skeletal muscle that the

energy set free during contraction varies with the length of the muscle at rest.

The "Law of the Heart" was published in 1914; work on the heart-lung preparation was interrupted by the war and then taken up with renewed interest in 1919.[18] It was found that this preparation afforded a means whereby any organ could be perfused with blood under known pressure and temperature. In 1922 a heart-lung-kidney preparation was developed and an effort made to give an account of the complex functions of the kidney; this was largely unsuccessful. The adaptation of the heart continued to interest Starling and he made studies on the metabolic changes in the heart muscle as it dilated. Here, he said that he felt he was in the realm of final causes and dealing with the nature of life itself.

Tired by illness, he continued to carry on in his laboratory, refusing all administrative positions. In the midst of his work he suddenly died in May of 1927 at the age of sixty-one.

In his last years Starling himself had summed up his life and achievements.[19] Glancing back he spoke of the rise of a great British school of physiology where none had existed before: "When I compare our present knowledge of the workings of the body . . . with the ignorance and despairing impotence of my student days, I feel that I have had the good fortune to see the sun rise on a darkened world, and that the life of my contemporaries has coincided not with a renaissance, but with a new birth of man's power over his environment and his destiny unparallelled in the whole history of mankind." He stressed the need for internationalism and co-operation between all the sciences, and glancing ahead saw the advance of science. Repeatedly he mentioned the great physiologists of the past, particularly William Harvey whose ideas he used every day and whose ideals were his ideals. His addresses were permeated with a spirit of unbounded optimism and enthusiasm for science and progress. It seems appropriate to end on this note that "in science . . . no advance is final. Every question solved produces new riddles to answer, since every higher step gives us a wider outlook and the power of seeing problems which from a lower level were not apparent. It is this indeed that gives

[18] Starling's "The regulation of the energy output of the heart" (*J. Physiol.*, 1927, *62*, 243-261) and "The secretion of urine as studied in the isolated kidney" (*Proc. roy. Soc.*, 1924, *B97*, 321-363) describe Starling's last work on the heart and heart-lung-preparation.

[19] Starling summed up his life and work in the "Wisdom of the body" and "A century of physiology." The last quotation is from the concluding paragraph of his "The physiology of digestion, gastric and intestinal."

to science its absorbing interest and makes it a fit occupation for a lifetime which, like all other phenomena of life, is but a link in the never ending chain of development of the intellectual powers of the race."

Notes and Queries

Edited by Ralph H. Major, M.D.,* and Dorothy M. Schullian, Ph.D.**

Dr. Webster's Prayer Book
An Addendum to the Webster-Parkman Murder Case

"America's Classic Murder," the Webster-Parkman case, is so well known it need not be presented here in detail.[1] Briefly, it concerns the mysterious disappearance of George Parkman, a wealthy Boston physician, who was last seen on Friday, November 23, 1849, at the Harvard Medical School. The following Sunday, John White Webster, who was the Ewing Professor of Chemistry at Harvard, declared that Parkman had visited him in his laboratory on the day he disappeared. On November 30th, just a week after Parkman vanished, human bones were uncovered in a privy vault under Webster's laboratory, which was in the Medical School. In addition, human bones and teeth were found buried in ashes in his laboratory furnace, and

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1 There were a number of contemporary reports of the case. "Report of the case of John W. Webster . . . indicted for the murder of George Parkman . . . before the Supreme Judicial Court of Massachusetts; including the hearing on the petition for a writ of error, the prisoner's confessional statements and application for a commutation of sentence, and an appendix containing several interesting matters never before published. By George Bemis." Boston, 1850.

"The Parkman murder. Trial of Prof. John W. Webster for the murder of Dr. George Parkman, November 23, 1849. Before the Supreme Judicial Court, in the city of Boston. . . ." Boston, Printed at the Daily Mail Office, 1850.

"Report of the trial of Prof. John W. Webster for the murder of Dr. George Parkman, before the Supreme Judicial Court of Massachusetts, holden at Boston, on Tuesday, March 19, 1850. Phonographic report, by Dr. James W. Stone." Boston, 1850. Second edition, revised, 1850.

"Trial of Professor John W. Webster, for the murder of Doctor George Parkman. Reported exclusively for the N. Y. Daily Globe." New York, 1850.

"Trial of Prof. John W. Webster for the murder of Dr. George Parkman. As reported for and published in the Boston Daily Times. Supreme Judicial Court of Massachusetts sitting in Boston, and Associate Justices Metcalfe and Wilde." Boston, 1850.

Trial of Professor John W. Webster, for the murder of Dr. George Parkman in the Medical College, November 23, 1849. Supreme Judicial Court for Suffolk, March term. Present Chief Justice Shaw, Associate Judges Wilde, Metcalfe and Dewey. Counsel for the Commonwealth—Hon. John H. Clifford . . . George Bemis . . . Counsel for the defense—Hon. Pliny Merrick . . . E. D. Sonier . . . Stenographic report, carefully rev. and cor. . . ." Boston, J. A. French, Boston, 1850.

"The trial of Prof. John W. Webster, indicted for the murder of Dr. George Parkman, at the Medical College, (North Grove Street,) on the 23rd of November, 1849. Supreme Judicial Court, before Chief Justices Wilde, Dewey and Metcalfe. Counsel for Government, Attorney General J. H. Clifford, and George Bemis, Esq. Counsel for the defense, Hon. Pliny Merrick, and E. D. Sonier, Esq. Reported for Boston Journal." Boston, 1850.

"Trial of John W. Webster . . . for the murder of Dr. George Parkman, including the hearing on the petition for a writ of error, the findings of the coroner's jury, the prisoner's confessional statements, application for a commutation of sentence, etc., being the report of John Bemis, with notes to subsequent cases involving questions of circumstantial evidence and the corpus delicti. By a member of the New York bar. . . ." Jersey City, 1879, 2 vols.

A modern version is available in George Dilnot's "The Trial of Professor John White Webster, with an introduction." London, 1928.

in a tea-chest a human thigh and thorax were discovered. Webster was arrested on the same day, charged with the murder of Parkman, which he denied. At the trial, Webster was accosted with the circumstantial evidence that the teeth found were those of Parkman. Evidence disclosed that Webster was in debt to Parkman, who had of late become quite insistent on repayment. Webster was tried and convicted. He was hanged for the murder on August 30, 1850.

In a confession made after the trial, Webster stated that Parkman had come to his laboratory threatening to oust him from his professorship if Webster did not repay him. Parkman was so abusive that he angered Webster, who seized a stick of wood with which he struck Parkman over the head. Parkman fell to the floor and Webster tried in vain to resuscitate him, but soon realized that he was dead. Panic-stricken, Webster could think of but one thing, to destroy the body and hide all evidence of the crime. He might well have succeeded had it not been for Parkman's teeth.

Although it is known that Webster was a Unitarian, little more is known of his religious belief. However, while he awaited the execution Webster's family had for several months "been in the habit of reading the Bible to him in his cell, taking the chapters of the New Testament in regular course, without skipping."[2] When he finally went to the gallows, Webster displayed a serenity which he said was based on religious conviction. There has been little elaboration of Webster's religious beliefs in the many discussions that have appeared concerning the trial, but a small prayer book, now in the Edgar Fahs Smith Library,[3] throws some light on this aspect of John Webster's character. It is entitled *Sacra Privata: the private meditations, devotions, and prayers, of the Right Rev. Thomas Wilson, D.D., Lord Bishop of Sodor and Man, accommodated to general use. . . ,* New York, 1845 (vi, 134 pp., 15.5cm.), and was read and annotated by John Webster while he was in the Suffolk County Jail (now Charles Street Jail) in Boston, awaiting execution.

This small, black, cloth-covered book, which is still in remarkably good condition, has a slip pasted on the outside of the front cover which bears the written inscription, "This book read and emended by the noted Prof. J. W. Webster while in prison awaiting his execution for the murder of Dr. Parkman. Boston, 1850." On a leaf pasted on the front endpaper appears the following:

2 "Bemis Report," 1850, *op. cit.*, pp. 606-607. This contains an abstract of the accounts of the last months of Webster's life taken from the *Boston Evening Transcript* and *Boston Daily Evening Traveller.*

3 Dr. Smith purchased the book sometime before 1921, since he spoke about it at the meeting of the Section of Historical Chemistry of the American Chemical Society in Rochester, N. Y., on April 27, 1921. Charles A. Browne writes in his "Reminiscences of Professor Edgar Fahs Smith" (unpublished manuscript in the Edgar Fahs Smith Library) that Smith spoke "of Webster's strong anti-religious feelings and of his erasing the name of the second person of the Trinity from his books." No copy of this lecture has been found among the typed manuscripts of Dr. Smith.

SACRA PRIVATA:

THE

PRIVATE MEDITATIONS, DEVOTIONS,

AND

PRAYERS,

OF THE

RIGHT REV. THOMAS WILSON, D. D.,
Lord Bishop of Sodor and Man.

Accommodated to General Use.

Lord, teach us to pray.—*Luke*, xi. 1.

NEW-YORK:
HENRY M. ONDERDONK,
25 John Street.
1845.

This Book read and
Emended by the noted
Prof. J. W. Webster
while in prison awaiting
his Execution for the
Murder of Dr. Parkman.
Boston, 1850.

(Courtesy Edgar Fahs Smith Library)

may succor and defend us on earth, ~~through Jesus Christ~~.

Grant me grace so to follow thy blessed saints in virtuous and godly living, that I may come to those unspeakable joys which thou hast prepared for them that unfeignedly love Thee.

I pray GOD, my whole spirit, (my understanding, will, and conscience,) my soul, (my appetites, affections, and passions,) and my body, (the tabernacle of my soul,) be preserved blameless ~~unto the coming of our Lord Jesus Christ~~.

May I take pleasure in abiding in thy presence, O GOD; in depending upon Thee; in leaving myself entirely to thy disposal, as a continual sacrifice to thy will.

Give me a victory over all my sins and imperfections; increase in me the graces *of faith, hope,* and *charity;* of *humility, meekness, patience,* and *resignation,* and all other Christian virtues; ~~for Jesus Christ's sake~~.

Preserve me, gracious GOD, from *spiritual pride;* from ascribing any thing I have done, or can do, to myself and robbing Thee of the glory of saving me ~~from eternal ruin~~.

Take possession, O JESUS, of thy right in my soul, which thou hast redeemed with thy most precious blood; and root out self-righteousness, self-interest, and self will; that thou mayst be my righteousness, and all in me.

sick; and the LORD *shall raise him up; and if he have committed sins he shall be absolved* {i. e. upon his confession.}

O LORD of life and death! have mercy upon all those who are visited with sickness; sanctify this thy fatherly correction, that they may search their ways, and see whence this visitation cometh. Have mercy upon all that are appointed to die, and grant that they omit nothing that is necessary to make their peace with thee, and that they may be delivered from death eternal. And GOD grant that we may apply our hearts to that holy and heavenly wisdom, while we live here, which may in the end bring us to life everlasting, ~~through Jesus Christ our Lord~~ *Amen.*

while we are in the world & say the children of Jesus Christ

NOON.

1 Tim. ii. 1. *I exhort, that first of all supplications, prayers, intercessions, and giving of thanks, be made for all men.*

Acts xvii. 26. *For we are all of one blood.* And Charity, that more excellent way, is a tender affection for the whole creation of GOD.

O GOD, almighty and merciful, let thy fatherly kindness be upon all whom thou hast made. Hear the prayers of all that call upon thee; open the eyes of them that never pray for themselves; pity the sighs of such as are in misery; deal mercifully with them that are in darkness; and increase the number of the graces

(Courtesy Edgar Fahs Smith Library)

> This book was sent to Dr. J. W. Webster, while in prison awaiting his execution for the murder of Parkman of Boston, by some benevolent person in New York who seems to have taken a Christian interest in his fate. The book was presented to the undersigned by a distant relative of Dr. Webster.
>
> The various marks, erasures, interlineations, emendata, which appear on the several pages of the book are those of Dr. Webster himself.
> Haverhill, Mass. 1870 R. H. Seeley

This leaf is pasted over a like inscription on the front endpaper itself. Written on the first fly leaf are the forwarding remarks of the "benevolent person in New York,"

> J. W. Webster with the sincere prayers of one to him a stranger New York—May 3rd. 1850
>
> "This is a faithful saying and worthy of all acceptation that Christ came into the world to save sinners"—1 st Tim.^{y} 1.c. 15. v.
>
> "There is a joy in the presence of the Angels of God over *one* that repenteth." Luke 15 c. 10. v.
>
> "We love Him—*because* He *first* loved us." 1 st John. 4 c. 19. v.

On the back endpaper there appears the inscription, "This book obtained by me at sale of Dr. R. H. Seeley's Library in Boston, 1886.— C. P. H. Nason Chelsea, Mass."

The various marks, interlineations, and emendata are Webster's, for a comparison of his handwriting here with that in a letter of the same period shows them to be the same.[4] The following are characteristic of his delineations and expurgations. On page 106, "I believe in God the Father, who had made me and all the world," is immediately followed by a statement on belief in God the Son, and in God the Holy Ghost, which Webster crosses out. Other passages of a like nature occur throughout the book, e.g., page 7, where Webster crosses out the words "We beg it for thy Son's sake," and page 9 where "through the merits of the Lord Jesus" is deleted, as are "for Christ's sake," page 11, and "Jesus obtain this grace for thy otherwise helpless creature," page 15. On page 17, the name Jesus is crossed out three times, whereas on page 18 "God" is written in place of the name "Jesus." Jesus or Jesus Christ is deleted four times on page 19. On page 21, an entire paragraph on belief in Christ and on His power is crossed out. The titles for Jesus "Author of the Way, Teacher of Truth, and Giver of Life" are all struck out on this page. Page 23 shows deletions similar to those in the rest of the book. On pages 29 and 42, the same words, referring to the second and third persons of the Trinity, are crossed out. Webster changes the text to read, "Glory be to God, my Creator [here Jesus and Holy Ghost are deleted], my Sanctifier, my Guide, and Comforter; all love, all glory, be to God most High. Amen."

The book, however, has many apparent contradictions and anomalies,

[4] Letter of John W. Webster to G. G. Smith, Esq. of Cambridge, dated 30 Aug. 1847, 3 pp. Webster's handwriting is discussed at length in the "Bemis Report," 1850, *op. cit.*, pp. 200-201, 203.

for there are places where Webster does not delete "Jesus" or "Holy Ghost." Such beliefs concerning Jesus Christ are found on pages 21, 25, 38, 52, 61 and 62, with pages 71 and 74 pertaining to the Holy Ghost. It is certain that Webster held Christ to be a disciple, not the son, of God. He also denies the concept of man's fallen nature, the devil, and hell (pages 51, 60, 73), as well as the doctrine of redemption (pages 23, 50).

From the above examples of the annotations in this prayer book, the conclusion that basically Webster held to the tenets of Unitarianism may be drawn.

There is a theological axiom that "As a man prays, so he believes." If this was true in Webster's case there may be, judging from his prayer book, reasons for accepting his contention that it was anger and not premeditation that led to his crime. This was well expressed by Edgar F. Smith who felt that "Dr. Webster had no thought of laying hands upon Dr. Parkman, whom he invited to come to his laboratory . . . It was simply to talk over his indebtedness. . . . Parkman was evidently very mad and he said things which it would be difficult for almost anyone to pass by."[5] Whatever be the truth, there is little question that John Webster's *Sacra Privata* is a unique addendum to the Parkman-Webster case.

Philadelphia, Pennsylvania HERBERT S. KLICKSTEIN

Travel Notes

DR. Howard Dittrick reports that on a delightful spot high up on a plateau in the foothills of the Adirondacks is "a building that harks back to the 1830's, when the College of Physicians and Surgeons of the Western District of New York was one of the three foremost medical teaching centers in the United States. Ten miles north of the Highway that runs through Herkimer, New York, there still stands the old chapel of Fairfield Academy, the parent institution where in addition to medicine the arts, religion, and military tactics were taught. Travelers will find this a picturesque drive from Herkimer along West Canada Creek to the scene of this memorable medical school."

Dr. M. Pierce Rucker deserves hearty congratulations for his work in bringing to notice shrines of medical history in the Commonwealth of Virginia. Readers are referred to his editorial, "A Medical Map of Historic Virginia," in the *Virginia Medical Monthly,* 1952, *79,* pp. 111-115. This article reproduces a map of Virginia, specially prepared by the Department of Conservation and Development, which shows the location of places of value to medical historians and the roads leading to them. Many of these places have descriptive highway markers. They are listed, with explanations, in the article, and the reader notes at once such familiar and eminent names

[5] Letter of Edgar Fahs Smith to Charles S. Palmer, Pittsburgh, dated 3 June 1921, 1 p.

as George Washington, Stonewall Jackson, Captain John Smith, Dr. Walter Reed, Jefferson Davis, Dr. Robley Dunglison, Thomas Jefferson, Dr. Jesse Bennett, and Dr. Ephraim McDowell. Medical historians in other states might well solicit from their state authorities similar recognition of medical shrines.

Great Ormond Street

On 14 February 1952 the hospital for children which is known in London and across the seas as "Great Ormond Street" celebrated the centenary of its existence. Its Senior Surgeon, Mr. T. Twistington Higgins, gives in the *British Medical Review* for 16 February a brief survey of its history, the prelude to a fuller account which he will issue in book form. Founded by Dr. Charles West in the house which once belonged to Dr. Mead, physician to Queen Anne, the institution was dedicated from the beginning not only to the relief of suffering among its small patients but also, through education of doctors, nurses, and mothers, to the work of prevention which, in its larger quarters, it still emphasizes today. The second hundred years open, in the words of Mr. Higgins, "with no diminution of opportunity or weakening of purpose."

L. T. Hobhouse Memorial Trust Lecture

The Hobhouse lecture "Technology and History," which was delivered by Dr. Charles Singer on 23 October 1951 at the London School of Economics and Political Science, has been published by Geoffrey Cumberlege, Oxford University Press, London, 1952.

D. J. Davis Lecture

The ninth D. J. Davis Lecture on Medical History at the University of Illinois College of Medicine, Chicago, was given on 9 April by Dr. Erwin H. Ackerknecht, Professor of the History of Medicine, University of Wisconsin. The title was "Diseases in the Middle West." The lectureship was established in 1943 by associates and friends of Dr. David J. Davis upon his retirement as Dean of the College of Medicine.

Webster-Gnudi Honors at Bologna

Dr. Luigi Belloni, Secretary of the Società Italiana di Storia delle Scienze Mediche e Naturali, reports on the honors paid to Dr. Jerome Pierce Webster and Dr. Martha Teach Gnudi at Bologna on 26 April in recognition of their monumental work *The Life and Times of Gaspare Tagliacozzi* (New York, 1950). At a special ceremony of the University at the historic Archiginnasio the degree of Doctor of Medicine *honoris causa* was conferred upon Dr. Webster, and a medal bearing the seal of the University was presented to Mrs. Gnudi, who had studied there. There followed

a visit to the Teatro Anatomico, which was destroyed by bombing on 29 January 1944. Restoration work has now begun, and it is the hope of every medical historian that the project can be carried to successful completion.

At a meeting the same day of the Società Italiana di Storia delle Scienze Mediche e Naturali an honorary membership was conferred, with fitting and eloquent remarks by Dr. Arturo Castiglioni, upon Mrs. Gnudi. Dr. Charles D. O'Malley was also made a member of the Society. At a joint session with the Società Italiana di Chirurgia Plastica the following papers on Tagliacozzi were presented: Jerome Pierce Webster, "A Sixteenth Century Portrait of Bolognese Doctor Tagliacozzi (?)" and "Tagliacozzi's Art as Practiced Today"; Martha Teach Gnudi, "L'Oroscopo di G. Tagliacozzi"; G. Sanvenero Rosselli, "Allievi e continuatori dell'opera di Tagliacozzi in Italia"; A. Gallassi, "La storia della rinoplastica dai Branca ai Vianeo e a Gaspare Tagliacozzi: rapporti di dipendenza"; L. Belloni, "Di una non avvenuta chiamata di G. Tagliacozzi allo studio di Padova (1594) e di un consulto epistolare fra G. Mercuriali, G. Tagliacozzi e G. Fabrici d'Acquapendente sopra un caso di fistola retto-vaginale"; L. Gentili, "Tagliacozzi e Aranzio: documenti inediti."

Fellowships in the History of Medicine and Natural Sciences

The Institute of the History of Medicine, of the Johns Hopkins University, announces the continuation of its fellowships in the history of medicine and of the natural sciences. One purpose of these awards, which provide from $2,000 to $3,000 in each case, is to supplement the training of young scholars who may have become interested in the history or sociology of science. Those who hold the M.D. or the Ph.D., or who have at least completed residence work for the latter degree, are eligible to apply. Three such fellowships were provided in 1951-52; a similar award for 1952-53 has now been made to Mr. John M. Hirschfield of the University of Chicago. Inquiries relating to 1953-54 should be made of the Director, 1900 East Monument Street, Baltimore 5, Maryland, preferably before December 15, 1952.

The Institute also announces the appointment of Dr. Ludwig Edelstein of the Johns Hopkins University as Lecturer in Greek Medicine; the appointment of Dr. Barkev S. Sanders, formerly Chief of Division of Health and Disability Studies, Social Security Administration, as Lecturer in Medical Economics; and the reappointment of Dr. Alexandre Koyré, of L'Ecole Pratique des Hautes Etudes, University of Paris, as Visiting Professor in the History of Science for the first semester, 1952-53.

Book Reviews

DEAN PUTNAM LOCKWOOD. *Ugo Benzi, Medieval Philosopher and Physician, 1376-1439.* Chicago, The University of Chicago Press, 1951. xvi + 441 pp. $8.00.

DURING his Chancellorship at The University of Chicago, Robert M. Hutchins often expressed a desire to change that institution's motto, "Crescat Scientia, Vita Excolatur." His preference would have been Walt Whitman's "Solitary, singing in the West, I strike up for a New World." It is well that in this regard he met resistance and that the old motto has continued to appear, especially on the title-pages of this and, at least implicitly, of a preceding volume of the University's Publications in Biology and Medicine. Dean Lockwood, writing on Ugo Benzi, and Israel Drabkin, writing on Caelius Aurelianus, are Latinists; they are, moreover, Eastern Latinists, and they write of a very old world apart from which no new world can emerge. The present motto looks to the future without forgetting the past, and their contributions furnish felicitous examples of its spirit. *Stet,* even while we concede that Whitman reveals elsewhere classical interests which are undeniable.

To most medical historians Dean Putnam Lockwood, Professor Emeritus of Latin and former Librarian of Haverford College, is known perhaps only for the Prolegomena to this book which he published in 1940 in *Transactions and Studies of the College of Physicians of Philadelphia.* (They would be interested also in his remarks on the history of medicine in *Journal of the History of Ideas* 1943, *4,* 64.) But the book has been a work of twenty years, and to it he has brought an exhaustive scholarship founded on the classical period and sharpened by investigation in the Middle Ages and the Renaissance. His two-volume *Survey of Classical Roman Literature* is a standard handbook for undergraduate students of Latin. He has contributed much elsewhere to modern knowledge of Aristophanes, Ptolemy, Rinucci, and Leonardo Bruni. He has collaborated with Charles H. Haskins and Roland H. Bainton. He is an Incorporator of the American Philological Association and a member of the Editorial Board for Mediaeval and Renaissance Latin Translations and Commentaries. He is finally, and most importantly for this book, a palaeographer of the school of Edward Kennard Rand, admirably equipped to handle the manuscripts of Benzi, and a librarian, possessed of a keen instinct in ferreting out printed editions of Benzi.

We expect therefore a profound study of Benzi and his works in relation to his times. Mr. Lockwood is fortunate not only in the training which he brings to the task, but also in having discovered quite by chance, in a manuscript of the Biblioteca Comunale at Ferrara, a biography of Ugo written

by his son Socino Benzi. The biography was indeed the starting point for this book, and by the very fact that it furnishes a wealth of material unknown to earlier students of Benzi the task of Mr. Lockwood is both enriched and augmented. He presents, after a brief Introduction, a translation of the *Vita* in which Socino's involved and often Italianate Latin is transformed into beautiful and vivid English; a careful discussion of Ugo's "philosophical" works, his works on medical theory, and his works on practical medicine, with a translation of one brief consilium entire, a translation of the more elaborate *casus* of another, a summary of the "cases" contained in each of the *Consilia,* and a summary of the eight *Treatises;* a lengthy chapter on medicine and physicians in the fifteenth century based on information furnished in the *Consilia;* and a shorter examination of Ugo's character as man and physician. It may well be that with the passage of time these last two chapters, because of the facts which they present on medical practices in Ugo's time and the provocative and still unsolved questions which they raise, will prove to be the most stimulating in the book, and that Ugo's most enduring contribution to medical history will become not his voluntary works and deeds, which are hardly startling, but his unconscious service as interpreter of his age. Mr. Lockwood is to be commended in particular for his realization that mediaeval medicine cannot be examined on the modern ideals of planned exploration and discovery, that it was "based on an elaborate system of knowledge utterly foreign to ours" which included a deep interest in the theories of the universe, and that the mediaeval physician can only be understood in the background of his own age.

This first third of the book, bristling with references to the sources, provided with classifications and opinions evolved from those sources, and pervaded, since this is a book by a scholar for scholars, with the scholar's obligation to take into account every possible shred of evidence, is scarcely light reading. On it follows a series of fifteen ponderous appendixes and twelve indexes which constitute the remaining two-thirds of the book and supplement with documents and further discussion the chapters listed above. The Latin text of the *Vita* by Socino is printed in full, together with shorter sources of value for Ugo's life. From these sources and from others previously published, which Mr. Lockwood terms so imperfectly edited as to be almost useless but which he uses nonetheless, the life of Ugo is outlined meticulously year by year. The known manuscripts of his works are classified and briefly described. The various *Commentaries, Quaestiones, Consilia,* and *Treatises* are outlined or excerpted or synopsized in the Latin or the Italian, often with an actual *apparatus criticus* and always with some attention to textual problems. The *Consilia* in particular are elucidated, and much attention is given to the formation of the entire corpus and to the significance of the term publication for Ugo's time. The printed editions of the works are carefully listed, and numerous copies located in both Ameri-

can and European libraries. The special and general indexes which conclude the book will be an enormous convenience to future students of mediaeval medicine in general and/or Ugo in particular.

Only someone who has had experience in editing manuscript texts can appreciate the vast amount of painstaking collation which has been necessary here. At other points the scaffolding remains visible. Especially in the driving effort to classify and segregate into compartments the information furnished by Ugo is the reader constantly reminded of the card-index system behind these pages. The information is of course staggering in amount, difficult of assimilation, and too often ambiguous, and the author often, and wisely, exercises care and caution when he treads on precarious ground; he is not afraid to say, and to say repeatedly, "I do not know"; "I wish I knew"; "I am not sure." He is in fact insistently present in his pages, now cautious, now modest, now breezily confident and writing with a sometimes startling freshness of language. There is much sanity in his translation of *mala complexio* by "malcomplexion," a term which, however, he does not use consistently himself, and of *a capite ad pedes* by "cap-a-pie."

In certain bibliographical and palaeographical practices the author does not always follow the road of orthodoxy. The reader will wonder why the cities Venice, Florence, and Bologna so often suffer abbreviation; why in some cases date and place of publication are not furnished; why occasionally a volume or page reference is missing. Garosi's study on Ugo was issued in 1933, not 1935, and in it the portrait of Ugo, which Mr. Lockwood says is published without indication of source, is clearly connected with the University of Pavia. In passages quoted from Larkey and Surphlet (p. 56), Castiglioni (pp. 61, 158, 198), Spencer (p. 62), and the *Catalogue of Books Printed in the XVth Century Now in the British Museum* (p. 382) there are certain inaccuracies of quotation. Inconsistencies in forms of names are to be expected in mediaeval texts, but they occur also in the author's English, and the reader is confronted, sometimes in the space of one page, with such discrepancies as Cermisonus and Cermisone, Marsilius de Sancta Sophia and Marsiglio, Johannes de Mantua and John of Mantua. Fol. 104 verso of the *editio princeps* of APH contains no marginal note (p. 36); the statement *Tertia de se est clara* occurs in logical order between the regular explicit for the second Particula and the incipit for the fourth. A 1518 edition of the same work is mentioned on page 218 but not listed on page 397. The Armed Forces *Medical* Library possesses a Venetian edition, published 10 May 1508, of the translations of Leoniceno which includes a tract thought by Mr. Lockwood (p. 225) to have been published first at Ferrara on 3 October 1509. The "ghost" edition of Ugo's AV which receives so much attention on page 393 and which was listed in the Index Catalogue *of the Library* of the Surgeon General's *Office* in 1885 was quietly laid in several lists of incunabula of that library, most recently in 1950; the library has two copies of the 1491 edition. This cataloguer, however, hails with ad-

miration Mr. Lockwood's discovery (p. 29 Sec. 20, p. 154 n. 15, p. 385, p. 396) that this edition contains a commentary on the second as well as the first fen of the first book of Avicenna's *Canon,* a fact which she, in company with earlier cataloguers in this country and abroad, had failed to note. To the list of locations on pp. 397-398 the Armed Forces Medical Library can now be added for AVF 1515, Cons. 1503, Trat. 1620. The New York Academy of Medicine Library has an imperfect copy of the 1510-1511 Pavia edition of Avicenna's *Opera,* the existence of which is doubted on page 394.

Collation from the manuscripts and editions of Ugo's works is not always uniform, and the reader searches in vain for a blanket, unequivocal statement of principles of transcription. With ingratiating frankness he is told instead in one instance (p. 238), and in fact has already suspected, that the *apparatus criticus* is only partial, haphazard, inconsistent, and that variants are sometimes reported indiscriminately from two editions. If the Italian on page 339 is taken from the 1481 text of the *Libro,* it is not reproduced "exactly as printed." The author realizes and hopes that more and better manuscripts may come to light; he terms his investigations even of those known to him limited, and he presents his texts as tentative. On page 201 the cautious and italicized "perhaps" can be deleted; the manuscript at Bologna did contain, on 29 November 1951, the *Consilium* by Johannes de Mantua, part of which Mr. Lockwood prints on pages 252-253. It would be pleasant and helpful to have an illustration of at least one page from the manuscript of Socino's biography of his father; the publisher's warning "No illustration . . . may be reproduced without permission of The University of Chicago Press" is superfluous.

In matters of translation, whether from Socino or from Ugo, no two classicists would ever agree entirely on material of this type written in a Latin which is decidedly not Ciceronian. This reviewer points out merely that "Parma" on page 28 Sec. 20 does not bring out fully the Latin *totum Parmensem agrum;* that on page 31 Sec. 27 the phrases *non ex urbe modo sed ex agro finitimisque oppidis* have been lost; that on the same page Sec. 29 "all the peoples of Italy, for there were none to whom he was not known" does not have the distinction made in *totius Italiae populi, quibus non minus cognitus erat quam suis;* that on page 32, in Castelli's Epitaph, the Vocative to Siena is omitted; that on page 59 line 33 the word "definition" translates *discussione* (?) on page 279 line 46, for which in turn the 1499 and 1503 editions read *diffŏne.* Of purely typographical errors and mistakes in spelling and syllabication this book is remarkably free; only a score are immediately apparent on a first reading, and author and press are to be congratulated on their success with this mass of complicated material. Consultation of the Appendixes would have been facilitated had all cross-references to them been given by pages; it takes time and effort to find an Appendix by number when the numbers do not appear in the headlines.

One feels a vast regret that in a work so admirably conceived and so

competently executed the author has seen fit to speak scathingly of many earlier workers in the subject. He does not hesitate to label a blunder great, a statement impossible, an assertion absurd. Judgments like "strange hodge-podge," "hasty edition," "mental inertia," "erroneous sketch," "strange lapse," and "obvious error" are freely passed upon the effort of historians and editors, medical and otherwise, from early times to the modern age. We all live in glass houses. No real scholar will wish to perpetuate errors; if and when they occur, they can be noticed in firm but also kindly fashion. Greater consideration is appropriate when the point is one of opinion, not of fact. This reviewer, fellow-classicist, Fellow-Roman, and fellow-librarian with the author, would make the special plea that those of us who, from another discipline, have turned to the history of medicine owe a particular measure of courtesy to acknowledged leaders in that field.

This is an important book. We need more books like it which will illuminate other mediaeval physicians and so finally limn for us in surer strokes the picture of mediaeval medicine as a whole. We need also the informal correspondence of these physicians, as Mr. Lockwood longingly recognizes on page 132. It is the prayer of historians in every field that such documents as have endured to the present day will continue to survive in an atomic age and to reveal their secrets one by one to the patient seeker.

Cleveland, Ohio DOROTHY M. SCHULLIAN

JOHN A. RYLE. *Changing Disciplines. Lectures on the History, Method and Motives of Social Pathology.* London, New York [etc.], Oxford University Press, 1948. x + 122 pp. 12/6.

JOHN Ryle was one of God's elect. To have known him in person was to have had the privilege of an inspiring experience. The imprint of his being endures, for he was one moved no less by depth of faith than by breadth of knowledge. The casual reader of the thin volume, *Changing Disciplines,* may not be thus impressed, and that were understandable. For Ryle was a modest man, devoid of pretensions and unwilling, as incapable, to affirm with finality that which he knew or believed in only tentatively. Such discreetness is not impressive, save to the discriminating.

Changing Disciplines is an integrated collection of essays, six in number, representing addresses and essays composed and delivered on a variety of occasions. Collectively, they exhibit the emergence and development of Ryle's insight into the *problems* of social medicine. This thin volume, counting, all told, 119 pages, is even now the very best *introduction* to the issue of social medicine. Its unique competence lies in that the *issue* is trans-illuminated by the personal experiences, the adventures in professional life of one who was an outstanding practitioner and a preëminent teacher of medicine. Here we encounter the compelling recitation of one who ex-

perienced profoundly and who, just as profoundly, meditated on his experience. It is by this pattern in growth that John Ryle came to be the incumbent of the first chair in social medicine at the University of Oxford. Ryle had been a successful practitioner. In 1935, he succeeded Sir Walter Langdon-Brown as Regius Professor of the University of Cambridge. Eight years later he was appointed Nuffield Professor of Social Medicine at Oxford. He died on February 27, 1950.

Ryle was cognizant of his mobilities. "I have asked myself," he wrote, "what was troubling my mind during the period of transition. . . . Looking back it has seemed to me that, while Medicine, through scientific and technical advances, has greatly gained in potentiality during the past quarter of a century, it has in the process become less surely attuned to some fundamental human needs—to the deeper personal needs of the individual and to the broader social needs of the group or community" (p. vi). In the same confessional vein he wrote: "Thirty years of my life have been spent as a student and teacher of clinical medicine. In these thirty years I have watched disease in the ward, studied more and more thoroughly—if not always more thoughtfully. . . . Man, as a person and a member of a family and of much larger social groups, with his health and sickness intimately bound up with the conditions of his life and work . . . has been inadequately considered in this period by the clinical teacher and hospital research worker" (p. 20). The dismal result is that "the morbid material of the hospital ward [the patients encountered there] consists very largely . . . of end-result conditions for which, as a rule, only a limited amount of relief repays the long stay, the patient investigation, and the anxious expectancy of the sick man or woman."

It was a deep disaffection with the "end-result" of current clinical medicine, and an awareness too of the fact that medicine had become "less surely attuned to some fundamental human needs" that moved Ryle to reach out beyond the "clinical fold."

Among the pioneers and disciples of social medicine there are but few who have come to it by a like road, or have brought to it such deep and significant insight. The larger number of so-called pioneers (*vide* Major Greenwood's *Some British Pioneers of Social Medicine,* Oxford University Press, 1948) in social medicine have been, as many of its disciples now are, sociologically, statistically, and epidemiologically oriented. As such they construe social medicine to be clinical medicine, to which has been added (or should be added) the data and formulations of the "social sciences." Such an addition is in the ultimate most desirable and necessary. But such a marriage will not and cannot result in the issue of social medicine. The latter can be achieved only by an initial recasting of the teaching and practice of clinical medicine. This is a basic conviction implied in all that Ryle has said of social medicine. At the head of the third essay, on Teaching and Research in Social Medicine, Ryle cites the (1936) Recommendation of the

General Medical Council, urging that throughout his entire period of study the student's attention should be directed to an appreciation of normal health, and how it may be assessed and maintained, as well as to the principles and practice of the prevention of disease. Herein, of course, lies the catch. Most of clinical medicine is founded on a study of the abnormal. Pathology and specific etiology are the chief preoccupations of the physician confronting the sick patient, with therapy as the logical derivative and negating agent to what the "man's got." How, then, is the attention of the student to be directed by his teachers, who themselves are ignorant of it, "to the importance of the measures by which Normal Health may be assessed and maintained?" Ryle does not provide the answer to this problem. He tells merely what he was endeavoring to achieve in these directions in—what he termed—the Oxford Experiment. But he returns to the theme in the fourth essay—The Meaning of Normal and the Measurement of Health. While Ryle here substantially expounds the need for statistically determined criteria of the standard norm, and of the normal range of variability, he also underscores the imperative need to study man physiologically and developmentally, rather than, and as well as, pathologically. It were indeed a great liberation in medical education were the study of physiology and growth and development given the preëminence now accorded to pathology and etiology.

It is fitting, and mirrors the man, that the closing essay should be devoted to Medical Ethics and The New Humanism. Herein Ryle deals not only with the ethics of the physician in a world of changing moralities, but also with the influence of the moral atmosphere upon the well-being of the group and the individual. This, surely, as Halliday has so brilliantly shown, is in the very core of social medicine.

Ryle died too young. Neither his life nor his work had come to full fruition. Had he had twenty more years of life, he would have left behind him a vastly greater heritage. As it is, he has given us the sight of the promised land and the inspiration and courage to go on. But to return to *Changing Disciplines*: It is a work that is not only the precious embodiment of a scholar's life-time preoccupation with the highest ends of medicine, but also a valuable and very practical exposition of the derivations of the problem of social medicine. It is one of those works which with time will grow in worth and significance.

I recall the week end in the summer of '48 I spent with him and his family at Sussex. He had been badly incapacitated by a coronary accident. Yet he was full of courage, and of good cheer. He was warmly enthused in his discussions on social medicine, and full of praise for his small band of associates at the Oxford Institute. He was interested in what we in the States thought about social medicine, and he had a sense of kinship with and for us. Despite the precarious state of his health he had about him a

sense of confidence as of one who was certain he had not labored in vain. And in this he was most surely warranted. However else he may be prized in time, he has most certainly gained preëminence as a modern pioneer in social medicine.

New York, New York IAGO GALDSTON

R. SCOTT STEVENSON and DOUGLAS GUTHRIE: *A History of Oto-Laryngology.* Baltimore, Williams and Wilkins Company, 1949. vii + 155 pp. $5.00.

Two dangers particularly beset the path of the medical historian who undertakes to deal with the development of a medical specialty. On the one hand, he may succumb to the desire to include as much detail as possible, in which case the final result is usually a dry-as-dust catalogue. On the other, wishing to enliven the story with items of human interest, he may be hoisted by his own petard and produce a mess of anecdotage. In the case of the volume by Stevenson and Guthrie, however, it is a pleasure to report that they have steered a skillful course between Scylla and Charybdis.

By concentrating on the advance of knowledge concerning the ear, nose, and throat, and on the application of this knowledge in dealing with the medical problems of these organs, the authors have produced a useful brief history. After two short chapters on the period from antiquity through the Renaissance, attention is devoted to the modern period from the seventeenth century to the present. For the most part the authors stick to the strictly technical aspects of the subject, although here and there reference is made to the organizational and institutional aspects of the specialty. Furthermore, some note is taken of the social aspects of the field by the inclusion of a chapter on the education of the deaf.

The volume is well illustrated and has a bibliography and index. All in all, this is a book to be recommended for the physician and the medical student interested in the growth of this small but fascinating field of medicine.

New York, New York GEORGE ROSEN

F. N. L. POYNTER *and* W. J. BISHOP. *A Seventeenth Century Doctor and His Patients: John Symcotts 1592?-1662.* The Publications of the Bedfordshire Historical Record Society, Vol. XXXI. Published by the Society at Streatley, near Luton, Beds., 1951. 126 pp. £1/5s.

THE Symcotts manuscripts comprise a case-book, a receipt book, medical notes, letters, wills, and other documents relating to John Symcotts and his family, and now housed in three repositories: the Bedford Collection; a manuscript of prescriptions and recipes in the hand of John Symcotts in the

Wellcome Historical Medical Library, London; and letters written to a patient by John Symcotts, in the British Museum.

The Bedford Collection has some one hundred documents, consisting of John Symcotts' medical case-book, his letters and prescriptions, and his will which are printed in full in this publication. Other documents are those relating to the next generation of the family.

John Symcotts was born about the year 1592. He went to Cambridge in 1608, took his B.A. in 1612, and his M.A. in 1615. In 1636 he received his M.D. from King's College. The earliest letter relating to him is 1628-29, but he was practising in Huntingdon years before that.

In the Civil War, Symcotts' sympathies lay on the parliamentary side. From 1647 to 1660 he frequently served on commissions concerning financial, military, and other matters in the county of Huntingdon. His practice extended over Huntingdon, Bedfordshire, and Cambridgeshire and he had many notable families in his clientele. Dr. Symcotts never married. There is a reference to him in Pepys' diary of 20 July 1661 at which time the diarist visited him in Huntingdon. Oliver Cromwell was at one time attended by him, and a reference to him occurs in the Bedford case-book. "Mr. Ol. Cromwell (long since) taking abundance of mithriade to avoid the infection of the plague, cured his pimpled face. . . ." Various members of the Cromwell family were also his patients. Other notables attended included Dr. John Williams, Bishop of Lincoln and afterwards Archbishop of York; Viscountess St. Albans, the widow of Francis Bacon; Sir Thomas Cotton and his family; and Sir Charles and Lady Harvard.

The Symcotts-Powers letters reprinted here show the relations between a doctor and his patients in that period. Powers lived ten miles from Huntingdon, suffered from gout, and apparently consulted other sources of advice. Symcotts speaks of the "wandering physician your doctor there," and says of his advice "I like it not. Such rowelling, drawing and slabbering smells too much of his barber's shop, from whence he came out doctor."

Gout and stone were two common diseases of the period and treated by Symcotts with diet and drugs. Other conditions mentioned are asthma, the King's Evil, and other forms of tuberculosis, agues, fevers, pleurisy, mumps, kidney disease, haemorrhagic dysentery, shingles, erysipelas, anorexia, anuria, conjunctivitis, epilepsy, palsies, melancholia, ringworm, and boils. He records an epidemic of "red fever" in children (scarlet fever). Smallpox was common. On his own statement he had three attacks of it. He also suffered from gout. In Symcotts' time the practice of obstetrics was almost entirely confined to midwives, physicians being used only in complicated cases or in Court practice. Symcotts was apparently called in from time to time in difficult cases.

His correspondence shows that in spite of using some of the remedies of the day, he recommended measures in hygiene and diet which appear to be sound practice. "According to the standards of his time Symcotts was

a skilled and experienced physician, shrewd, patient, humane and resourceful."

The presentation of these records in available form is a distinct contribution to the annals of medical history.

New Haven, Connecticut HERBERT THOMS

WELLCOME HISTORICAL MEDICAL MUSEUM, LONDON. *Catalogue of an Exhibition Illustrating Prehistoric Man in Health and Sickness.* With an Introduction by E. Ashworth Underwood. London [etc.], Geoffrey Cumberlege, Oxford University Press, 1951. 56 pp. 60¢.

THE Wellcome Museum, London, is noted for its collections bearing on the life of prehistoric and primitive man in health and sickness. The present exhibition deals with prehistoric man, and it must prove of great interest to anthropologists and medical men who have the opportunity of seeing it. To those of us who cannot, the printed catalogue and especially the introduction by the Director of the Museum cannot fail to be both interesting and instructive. Dr. Underwood gives a clear summary of the historical stages by which geology and archaeology became established as sciences in spite of the opposition of theologians of the past. One cannot help wondering by what process Bishop Usher at the end of the seventeenth century arrived at his creation date of 4004 B.C. and by what further arithmetical deduction Bishop Lightfoot was able to assert that the creation actually commenced at 9 a.m. on the morning of October 23, 4004 B.C. However, in spite of church opposition, the geologists were able to establish their geological periods extending back to the Pre-Cambrian 3,000 million years ago, and the palaeontologists were able to fit the duration of various forms of life into the geological record. It is interesting to note from Figure 1 that bacteria and invertebrates appeared in the Pre-Cambrian over 320 million years ago and man did not make his tardy appearance until the Quaternary period, a paltry million years ago.

The skeletal remains of prehistoric man in calvaria and pieces of skulls are now preserved in various museums. The various types of man from Pithecanthropus to Neanderthal and Cro-Magnon man are represented in the Wellcome Museum by casts, but the Museum is fortunate in also possessing the original Châtelperron skull which forms an important addition to our knowledge of men of the Cro-Magnon race whose brains had a higher cubic capacity than those of our modern Homo Sapiens. The artifacts made by prehistoric man have been classified by archaeologists into various prehistoric cultures from early Abbevillian to late Magdalenian and post-Palaeolithic. These are represented in the exhibition by casts and original specimens in series following a time sequence. In addition to artifacts

there are transparencies of the wonderful paintings in colour of extinct animals from caves during the Magdalenian period when prehistoric art reached its highest development. Thus a complete record is provided of the various extinct animals that early man hunted for food. Figure 2 gives a fine table in which the geological divisions of the Quaternary period with its four glaciations and three ages of Lower, Middle, and Upper Paleolithic are correlated with the appearance of the different types of man and the prehistoric cultures.

The record of prehistoric man and animals in sickness is limited by the fact that only the pathological lesions affecting bones and teeth could survive the decay of time. The available records have received due attention in the exhibits. The oldest vertebrate fossils provide evidence that the extinct animals of bygone ages suffered from some of the bone diseases known today. An interesting exhibit from the Lower Cretaceous is that of the oldest known tumor which affected the intervertebral region between two caudal vertebrae of a dinosaur. Histological sections showed that it was a type of haemangioma. Other specimens include arthritis deformans in the caudal vertebra of a horned dinosaur, diseased mandible of a three-toed horse, cytoma from the mandible of a four-tusked mastodon, and diseased thoracic and lumbar vertebrae of a sabre-toothed tiger. Bone fractures and reindeer bones with imbedded arrow heads add to the collection.

The evidence of bone trouble in prehistoric man commences with Pithecanthropus erectus whose femur showed marked exostosis of a pathological nature. Examples are shown of healed unreduced fractures of the long bones, some showing very little overlapping of the fragments. Frequent injuries to bones by cutting or piercing weapons indicate that differences of opinion were settled in the same way as they are now. Two instances of arrow heads imbedded in the front of the vertebrae show the strength of the bows in sending an arrow through the thickness of the human body. Skeletal remains indicate the frequency of arthritis deformans and allied conditions. The earliest record of gall bladder trouble is provided by a neolithic skeleton with a number of gallstones lying near the spine.

Evidence on the practice of medicine is scanty, but it is inferred that seeds and herbs were used to alleviate certain symptoms. Dr. Underwood accounts for the paucity of drawings of plants as compared with those of animals by the fact that stationary plants were easily obtained, whereas animals were elusive and their representation was part of a magical practice to ensure supply. Copies of the few crude drawings of plants are shown. More evidence was available in neolithic times and specimens of the seeds of twenty-six identified plants from the Swiss Lake Dwellings are shown. Among the plants grown were the *Papaver somniferum* (opium poppy) and *Verbena officinalis,* which have medicinal properties. Evidence exists that the water of mineral springs was used medicinally.

The statement that considerable and impressive information exists that prehistoric people practised a crude form of surgery is difficult to support with archaeological specimens. However, a large series of implements from Abbevillian to Late Solutrian are shown under the special grouping of "Evolution of the Surgical Knife." Though they may have been made primarily for other purposes, they also provided the sharpest edges that could be used for surgical purposes. Five specimens of neolithic skulls with trephined holes in one or other parietal bone, illustrate the fact that prehistoric man frequently performed the deliberate operation of trephining the skull. Various theories have been advanced for the reason of the operation. The relief of cranial fractures is ruled out by the absence of fractures in most of the trephined skulls. Another theory that the round disc of bone or "rondelle" was used as an amulet receives support from an exhibit of four rondelles perforated for suspension. There was probably more than one reason for the operation.

In the exhibit, each specimen has adequate information regarding the place of discovery and the prehistoric culture to which it belongs. Cast labels also indicate what institution houses the original. For the whole arrangement, Dr. Underwood and his assistant Mr. A. D. Lacaille deserve the highest credit for providing an exhibition which is unique, interesting, and highly instructive.

PETER H. BUCK*

EUGENE F. SNYDER. *From a Doctor's Heart.* New York, Philosophical Library, 1951. xvii + 251 pp. $3.75.

WHAT is coronary thrombosis? Dr. Snyder uses the term as synonymous with myocardial infarction. Does a physician feel differently than the ordinary person when he is stricken? What he does and how he resigns himself finally to the new situation of impending death and the threat of permanent invalidism form the theme of this book. Not obesity, of which he was a manifest victim, but overwork is, according to the good doctor, the cause of his misfortune. He had obviously lived a harrowing life, first as a refuge from the U.S.S.R., then from Hitler's minions in Czechoslovakia. As a practitioner in Chicopee Falls during the war he worked day and night without rest or surcease. Always he was running. It is not surprising therefore that his flight through life should become a cause of his heart disease and that relief from flight, namely, rest, should be the keystone of his recovery. His search for mental and physical rest led to religion as well as to the old, almost abandoned view of excessive rest in the treatment of his malady. His belief in rest is stated passionately over and over again and is made the sage advice of a wise old practitioner, though it is contrary to

* Died 1 December 1951.

more recent knowledge on the abuse of rest in the treatment of heart disease.

This story is different from most other books on heart disease in that this is a personal account of a humane and astute physician in the throes of a severe heart attack. How he changed pain into resignation, despair into hope, and defeat into courage is movingly told without sacrificing the informative and instructive purpose of the book. The most pertinent facts that a layman should know about etiology and classification of heart diseases are brought out through a discussion between the author, his wife—also a physician—and his teen-age son. Not neglected is the important relationship between mind and body: the nature of the nervous heart, and the manner in which emotions of fear and rage may precipitate a heart attack. Specialists and general practitioner move through its pages, but the blue ribbon is tendered to an idealized general practitioner who shows a profound feeling of humanity, and great skill in the art of healing, and who is imbued with the psychological aspects of illness. Such a character is worth while knowing, even if he must be discovered in a book.

The book opens with a dedication to the memory of his parents who were brutally and senselessly murdered by Hitler's Germans, as well as an expressed hope that we perpetuate the principles of liberty, charity, and integrity as the only paths to peace and goodwill among men.

Then follows a foreword by Dr. Paul D. White, a reproduction of the Hippocratic oath, and a doctor's morning prayer by Edith Tatum.

As he describes his illness and the cause of his recovery, he slowly arrives at the realization that life can be more meaningful to one who almost lost it even though he survives physically handicapped. The last chapter summarizes for others the ways in which the author gained serenity and an inner peace at the most dangerous moments of his illness.

Each of the ten chapters begins with an apt quotation establishing the mood which is further solidified by eighteen cartoons in the modern form. The bibliography which follows affords an opportunity for a first-class education to any one who would take the time to read through the references.

The author himself believes that his main purpose in writing the book is to make people aware of the great possibilities everyone possesses to prolong his life and to encourage each one to use proper care. But the "understanding heart," one full of sympathy and faith in humanitarian and democratic idealism, while not his main purpose, was certainly a deep well out of which he drew abundantly throughout his discussions on his main purpose. Because it has science, religion, and humanity all in one it should appeal to all who read it.

New Haven, Connecticut LOUIS H. NAHUM

LEWIS J. MOORMAN. *Pioneer Doctor.* Norman, University of Oklahoma Press, 1951. xvii + 222 pp. $3.75.

FOR the student of the history of medicine Dr. Moorman's book gives the outlines and much interesting detail of a chapter of American medical history that will not be repeated. It tells a story that could be recited, with variations, by many other physicians of his generation who followed their calling in the Western part of the United States. Hundreds of young graduates of the medical schools in the Ohio and Mississippi valleys and along the Atlantic seaboard migrated westward to cast their lot with the pioneers who had broken the sod and laid out the town sites of the great West and Southwest. Many of these doctors had received their training during the decade or two immediately following the etiological period of medicine of the 1880's. They matured professionally as the new states or territories in which they settled developed economically. Some, like the author of this volume, attained international renown in specialties which they eventually adopted.

The life and environment of the pioneer doctor were not conducive to specializing in medicine or to the development of studious habits, but many of these physicians demonstrated that neither professional competence nor scholarly attainment was dependent on the age of their communities. Recognition of need for further training resulted, and Dr. Moorman, as did many others of his period, went to Europe, where he studied in Vienna, the great graduate medical training center of the day.

The pioneer doctors not only looked after the sick and injured in a fast growing population living under rough and primitive conditions, but they also organized and built the medical schools that were needed to supply more physicians as the number of people increased. Many of the schools they founded are now blossoming into excellent institutions. The doctors who built them and improved standards of medicine and sanitation in their respective communities had their difficulties and heartaches, but they also had lots of fun. Those who survive can look back with great satisfaction at the foundations they laid.

The experiences of the young doctor with epidemics, treatment of Indians, quacks in the community, caring for patients with gunshot wounds and other injuries common in frontier communities, and in meeting the numerous other demands upon the physician, are delightfully told.

Dr. Moorman has done a service to the history of medicine in recording a part of the story, as typified by one physician's experiences, of the professional development of a great empire. The rapid growth of medicine, the changes in methods of transportation, and social transformations will make the medical practice of the American frontier appear very strange to the reader of medical history a few generations hence. Perhaps some of these readers, who may have sufficient imagination, will share the author's nos-

talgia for the open spaces, the horse and buggy doctor's long drives under the stars, and his close personal relationships with his patients.

As an authentic account of an epoch of American medicine and its sociological aspects, this book is of permanent importance. It is also very readable.

Portland, Oregon O. LARSELL

WELLCOME HISTORICAL MEDICAL MUSEUM, LONDON. *Catalogue of an Exhibition Illustrating the History of Pharmacy*. With an introduction by E. Ashworth Underwood. London, Oxford University Press, 1951. 59 pp. 60¢.

WITHIN the frame of the British "Festival Period," this proud and meaningful show of what—war or no war—English talent, will power, and resources (or resourcefulness) are able to offer, the Wellcome Historical Medical Museum presented the exhibition to which this catalogue bears witness.

The reviewer has not had the privilege of seeing the exhibition. But he has read the descriptive reports published on the occasion of the opening in the English pharmaceutical press, especially *The Pharmaceutical Journal* (June 16, 1951) and *The Chemist and Druggist* (May 26, 1951), and he knows the treasures of the Wellcome Historical Medical Museum from prewar visits. It was long before war emergencies forced this unique institution out of its delightful residence that this reviewer published an illustrated article on "Pharmacy in the Wellcome Museum in London" (*Pharm. Ztg.*, 1934, *79*, 214-217). The knowledge of the alluring *embarras de richesse* at the disposal of the people responsible for this exhibition makes their selection, their wisdom of choice, all the more admirable.

The concept "pharmacy" is taken in its widest aspect, covering the sum total of all scientific, practical, and organizational activities devoted to the preparation and distribution of drugs. The items were exhibited (and are listed in the catalogue) in the following fifteen divisions:

I. Ancient Egypt; II. Classical; III. The Middle Ages; IV. The Sixteenth Century; V. The Early Herbals; VI. The Seventeenth Century; VII. The Eighteenth Century; VIII. The Chemical Revolution; IX. Chemical Laboratories; X. Application of Science to Pharmacy; XI. Pharmacology; XII. Serum Therapy and Chemotherapy; XIII. Cinchona and Ergot; XIV. Historic and Curious Remedies; XV. Vessels for Pharmaceutical Preparations.

Dr. Underwood, who took over the leadership of the Wellcome Historical Medical Museum a few years ago and under whose guidance the exhibition was prepared, has provided the Catalogue with an introduction that is a masterpiece of a concise survey. In about eight pages the reader receives a general idea about the most important steps in the development of the art

and science of pharmacy. There is, in the opinion of the reviewer, only one omission of importance: a reference to the 1240 edict promulgated by Frederick II of Hohenstaufen which separated pharmacy from medicine on European soil. There is only one misprint of any meaning: the title of Saladin de Asculo's treatise on pharmacy reads "Compendium Aromatariorum," not "Armamentorium."

It may be mentioned that this exhibition was preceded by three other ones prepared under the direction of Dr. E. Ashwood Underwood. The first was devoted to "The Bicentenary of Edward Jenner" (1949), the second to "Medicine in 1850" (1950), and the third to "Prehistoric Man in Health and Sickness" (1951). Every one of the catalogues issued on these occasions has an illuminating introduction from the pen of Dr. Underwood. The catalogues are listed as Nos. 1, 2, 3 and 4 of a series called "Publications of the Wellcome Historical Medical Museum, Occasional Papers Series."

It is hoped that these exhibitions and these papers will be continued *ad infinitum*. The treasures of the Wellcome Historical Medical Museum and the knowledge and ingenuity of its Director make this hope reasonable.

Madison, Wisconsin GEORGE URDANG

S. ROODHOUSE GLOYNE. *John Hunter.* Edinburgh, E. & S. Livingstone Ltd., 1950. 104 pp., illus. 15s.

IN this "short monograph," as he called it in his preface, the late Dr. S. Roodhouse Gloyne gave himself little enough room to deal with one of the most various and prolific of eighteenth century scientists. There is nothing new in the biography, no fresh perceptions in the account of Hunter's work. Nevertheless, it is a very good book. Following Stephen Paget's chronological arrangement of the facts of Hunter's life, Gloyne produced a better balanced, more shapely essay than Paget's. Relying chiefly, although not entirely, on secondary sources, he cross-checked with care and chose the more reliable of conflicting reports. Except for minor inadvertancies and matters of opinion (e.g. he thought that Hunter would have gained by a longer stay at Oxford), it would be hard to object to anything he says without some rather elaborate documentation. I think his opinions are in general sound, and he has the great advantage of real familiarity with Hunter's writings. His views may not be startling but they are certainly his own.

Is this a good portrait of Hunter? In broad outline, yes. But Dr. Gloyne, who thought as he wrote, urbanely and pleasantly, seems to have been rather pained by Hunter's many and often somewhat foolish quarrels. He had neither the space nor the inclination to go into these matters. It is perhaps the part of wisdom to pass them over as battles long ago; to do so, however, is to make Hunter seem a little finer-grained than he was. In the intellectual sphere, the difficulties are explained in the usual way, i.e., Hunter was a

bad writer and could not give a clear account of himself; the metaphysical element in his works is not important for it proves nothing except that he soon became wooly-headed when not in close contact with facts. These assertions are no doubt true but they are also much too easy. They are explanations which do not explain.

Since the biographies by Stephen Paget and George C. Peachey are out of print (Peachey's excellent *Memoir* is hard to find) the book under review is cordially recommended as the best general account of John Hunter now easily obtainable.

London, Canada LLOYD G. STEVENSON

DANIEL DRAKE. *An Inaugural Discourse on Medical Education delivered at the opening of the Medical College of Ohio in Cincinnati, 11 November 1820.* With an introduction by Emmet Field Horine. New York, Henry Schuman, 1951. xxx + 31 pp. $5.00.

IT is a paradoxical situation that a document as important as Daniel Drake's *Inaugural Discourse* should not have been easily accessible. Yet Dr. Horine tells us that until the publication of the present volume, only eighteen copies of the speech were known to exist. The new edition is a limited one, handsomely printed and bound. A facsimile of the original title-page is included.

The status of early medical education in the United States and Drake's contributions during the nineteenth century are summarized in Dr. Horine's excellent and carefully annotated introduction. Drake's reputation as a medical educator was such that at the age of thirty-five he became President of the Medical College of Ohio (now the College of Medicine of the University of Cincinnati), the second medical school to be opened west of the Alleghenies. In his inaugural address on 11 November 1820 he stressed such "modern" ideals as the importance of a liberal education as a foundation for medical training, "acute and patient observation at the bedside of the sick," and the necessity for a hospital as a close adjunct of a medical school. His phrases and his ideas are as stirring today as they must have been more than one hundred and thirty years ago.

New Haven, Connecticut THOMAS R. FORBES

J. S. SIMMONS, T. F. WHAYNE, G. W. ANDERSON, H. M. HORACK, and collaborators. *Global Epidemiology. A Geography of Disease and Sanitation.* Vol. 2: Africa and the Adjacent Islands. Philadelphia, J. B. Lippincott Co., 1951. xl + 652 pp.

THIS second volume of *Global Epidemiology* maintains the high quality and comprehensive scope of the first volume of seven years earlier which

dealt with India, the Far East, and the Pacific area. Here is provided a concise summary, by political units, of health conditions on the continent of Africa.

The eight sections deal respectively with the Nile Valley, the Ethiopian highlands, East Africa, the Islands of the Indian Ocean, South Africa, Equatorial Africa, West Africa, and Northern Africa. Each section covers, for individual parts of the areas considered, the topics: geography and climate, population, socio-economic conditions, environment and sanitation, health services and medical facilities, diseases, and includes a summary and bibliography. A useful appendix gives maps showing distribution of the principal tropical diseases and practical 'Health Hints for the Tropics.' Interrelationships of cultural, economic, and social problems are apparent and bring a reminder from the preface to the first volume which stated essentially that public health is vital to a nation's strength, that problems of international health become accentuated as rapid communication shortens distances, and that spread of information regarding each other's problems of health is essential.

This series was undertaken during World War II by the Preventive Medicine Service of the Office of the Surgeon General of the United States Army following a proposal originating in the Committee on Information of the Division of Medical Sciences of the National Research Council. The authors were associated with the Medical Intelligence Division which was charged with the responsibility for collecting and assembling data relating to the medical, health and sanitary conditions in many regions of the world. Such information has recently been supplemented for this volume by extensive library research, by visits to the areas considered, by conferences and correspondence with authorities. The original concept of these important publications has broadened constructively as public health has become increasingly international in scope.

Every library concerned with health and medical affairs should have a copy of this basic work. Furthermore, the modest hope of the authors should be more than realized that "the dissemination of the data presented in this series will be of assistance, not only to professional workers in the fields of medicine and public health, but also to the agencies working toward world understanding and international cooperation."

New Haven, Connecticut IRA V. HISCOCK

BENJAMIN RUSH. *Letters.* Edited by L. H. Butterfield. [Princeton], Published for The American Philosophical Society by the Princeton University Press, 1951. 2 vols. $15.00.

READING this collection of Rush letters, from the first written in 1761 to the last with the date of 1813, is like walking through a hall of mirrors in which people, events, and scenes in Philadelphia during the American

Revolution, the decade preceding it, and the quarter century or more following its battles are reflected, and, by some miraculous process, preserved for our scrutiny. In these mirrors we may look at soldiers and generals of the American Revolution and at members of the Continental Congress signing the Declaration of Independence; at battle scenes and peaceful landscapes with serene figures; at celebrities in action and commonplace citizens in the market place; at churches and their preachers, colleges and their presidents, a hospital with its doctors and patients; at medical students and teachers, at Quakers, Indians, Negroes, foreign visitors, American statesmen. As in a mirror, darkly, we shall see these things, not with photographic exactitude as in a twentieth century picture magazine, for these images are only the subjective impressions of a letter-writer. When the figure of Benjamin Rush himself appears in the foreground, he often seems magnified to the proportions of a superman with few equals among his contemporaries, some of whom shrink to the stature of Lilliputians in the mirror-like reflections of the letters, while others, distorted as it were by the curvature of the glass, seem caricatures of figures known to us quite differently in the unprejudiced pages of formal history where judgment has cooled with the passage of time.

It is customary to forgive or to overlook the egotism displayed by the prolific letter-writer or by the diarist, since unless he possessed some characteristic of the exhibitionist, we should not be able to profit from his one-man view, recorded as it were on the spot, of events as they occur—events, as soon as over, fashioned into the fabric of the past which we cannot ever recapture nor have the privilege of examining close up, to see for ourselves exactly what happened and pronounce our own judgment. How much we owe to observers such as Evelyn and Pepys, John Aubrey and Thomas Fuller, Dr. Johnson and his Boswell, Horace Walpole—and to the ready pen of Benjamin Rush whose correspondence flourished for more than fifty years! In all these men self-consciousness, although in a measure submerged by the importance of the events they chronicled, provided motivation for self-expression and for appraisal of all that they saw and experienced in differing, individual ways, each according to the capacity of his nature.

The devotion which Rush expresses in early letters to the cause of the young nation emerging from dependence upon Great Britain to stand for liberty, freedom, and opportunity reveals his innate idealism and the passionate nature which during his entire lifetime was to find employment in every cause demanding men of principle. Emotion was the mainspring of his action. It is as *a man of feeling* that he will be longest remembered, marching in that grand procession of eighteenth century humanitarians whose primary compulsion "to spend and be spent for the Good of Mankind," as Rush phrased it, brought often in its exercise satisfaction to a craving for recognition and appreciation which was perhaps as urgent in their natures as their feelings of benevolence.

Wherever there was a difficult task, Rush was ready to take the lead in attack. In more peaceful times and in an older country with a stabilized culture, Rush's talents might have made him a first-rate actor, such were his gifts for rôle-taking. In Philadelphia his abilities were harnessed for use in real life. Through choice of profession a physician, he found his work as one of the founders of America's first medical school most gratifying because of the opportunity it gave him to instruct young men. At the same time he was shouldering the responsibilities of a hard-working doctor which as he recounts them became almost overwhelming, witness his heroic struggles against yellow fever when it raged in his city. Wrong-headed in his theories, opposed by his colleagues for his overdoing of bleeding and purging, Rush stains the record of these epidemic years with controversies. In spite of criticism for rashness Rush established an enviable reputation for taking responsibility, perhaps his most admirable characteristic. Civic duties were thrust upon him, and his response was—hard work.

As the years rolled by, Rush was foremost among Philadelphians in every fight against oppression, ignorance, and what he considered folly. He was, in fact, a "do-gooder" of the first rank whose causes embraced the spread and reform of education, justice, and opportunity for the Negro and the Indian, temperance, organization of the currency, humane care for the insane, and the introduction of occupational therapy in asylums where madmen had been chained. There were lesser projects to engage his interest in hours otherwise idle. He forgot the heat of summer while writing lectures, essays and articles for the newspapers. He loved to organize societies for ideal or practical purposes, to help the Africans build a church, to serve on committees to select a college president or a clergyman, to plan for the organization of a maple sugar industry to prevent importation of cane sugar from the West Indies where slave labor was employed. Another pet project, which was never carried far, was a proposal to ban from the curriculum of schools in this country the study of Latin and Greek, "which by enabling us to read agreeable histories of ancient crimes often lead us to imitate or tolerate them."

In his early maturity as a member of the Continental Congress and a signer of the Declaration of Independence, Rush first became closely associated with colonial leaders who were to mould the policies of the newly forming United States. With two of these leaders, Thomas Jefferson of Virginia and John Adams of Massachusetts, he later sought to establish intimacy through exchange of ideas in correspondence. The letters he wrote to these men are his best, for to win their approval was a challenge to show the best side of his nature. Letters to George Washington, to Patrick Henry, and to William Shippen show him in a different light when he had grievances. His sons sought to suppress this damaging evidence, mutilated the confessions of his autobiography, and for years prevented its publication.

Struggle was the inevitable portion of young America, not only during the

Revolution but afterwards in its efforts for establishment and expansion, and Philadelphia in its development as part of the United States could not avoid suffering from "growing pains." Unfortunately, in these unsteady times Rush engaged in many personal quarrels, for he was not gifted in understanding people whose views and temperaments were different from his. It is evident that he always wished to be the leader in enterprises which enlisted his interest. If he had been director general of the Army hospitals, would the death rate have decreased? Could he have been omnipresent and omnipotent in the many crowded temporary hospitals, widely scattered, scantily supplied with bedding and necessities, which disease invaded as it had invaded all military hospitals from their earliest establishment and would continue to invade them, even the British Army hospitals which Rush thought perfect in organization, until preventive medicine made great strides of discovery? Could Rush by sheer will power and desire to do good have controlled the unsanitary conditions leading to the rise and spread of putrid or hospital fever which for more than a hundred years longer would kill more men by the thousand herded in military hospitals than those who fell on battlefields? In the Crimean War it took a Florence Nightingale to perfect plans for partial solution of similar difficulties, and it is only during the present Korean struggle with its almost unbelievably low mortality rate that the Surgeon General of the United States Army is willing to declare that we have total medical control in Army hospitals.

Whatever the final verdict upon Rush, and there will be differing opinions, he was a vitally interesting person, and these two volumes of his letters are an important addition to the history of American life, thanks to the scholarly editorship of Mr. Butterfield whose work as co-editor of the Jefferson Papers has already brought him well-deserved laurels. Even the excellent index which enriches the Rush Letters makes fascinating reading, looked at separately by itself as a kind of skeleton upon which the full body of this work depends for active use.

Baltimore, Maryland BETSY COPPING CORNER

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